City of Bonner Springs Water Supply & Treatment Plant Project

WIFIA Letter of Interest

Appendix A: Facility Plan

FINAL

CITY OF BONNER SPRINGS WATER SUPPLY AND TREATMENT PLANT STUDY

Facility Plan

B&V PROJECT NO. 404408

PREPARED FOR

City of Bonner Springs, Kansas

18 MAY 2020

BLACK & VEATCH

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1.0 General

1.1 PROJECT DESCRIPTION

The City of Bonner Springs Water Treatment Plant Project will include construction of a green field high rate precipitative softening plant (WTP) adjacent to existing utility operations buildings near the existing water treatment plant. The existing plant will not be reused or incorporated into the new facility. The new 2.0 MGD firm capacity plant is based on recommendations from the Water Treatment Technology Evaluation dated March 2020 and will include the following:

- Operations Building to house chemicals and provide working space for operations and maintenance; space will include offices, meeting/lunch room, restrooms, server/safe room, controls room, parts storage, laboratory, electrical room, filter gallery and chemical storage rooms.
- High rate packaged treatment systems; skids will include basins for rapid mix, reactor and a clarifier/thickener. The system will be designed for two 100% capacity trains.
- Recarbonation basin with a CO2 tank and feeders.
- Packaged gravity filters; skids will be located within the new Operations Building. The system will be designed for plant firm capacity with one filter off-line for backwashing.
- Filter backwash storage tank and pumping station.
- Packaged Lime Storage and Feed System including storage silo, lime feeders, slaker, slurry storage tank, slurry feed pumps and associated piping, valves and appurtenances.
- Packaged Soda Ash Storage and Feed System including storage silo, solution tank, solution feed pumps and associated piping, valves and appurtenances.
- Sodium hypochlorite Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The sodium hypochlorite system will be housed in the Operations Building.
- Coagulant Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The coagulant system will be housed in the Operations Building.
- Fluoride Storage and Feed System consisting of tote storage, day tank, metering pumps and associate piping, valves and appurtenances. The fluoride system will be housed in the Operations Building.
- Phosphate Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The phosphate system will be housed in the Operations Building.
- Liquid Ammonium Sulfate Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The liquid ammonium sulfate system will be housed in the Operations Building.
- Polymer Storage and Feed System consisting of tote storage, metering pumps and associate piping, valves and appurtenances. The polymer system will be housed in the Operations Building.
- Treated Water Reservoir consisting of a below grade concrete basin.

- High Service Pump Station located above the Treated Water Reservoir containing three high service discharge pumps and one backwash supply pump and associated piping, valves and appurtenances.
- Lime Residual Treatment Facility (earthen lagoon) located in an adjacent property for storage of lime residuals.

1.2 BACKGROUND

The City of Bonner Springs' existing Water Treatment Plant is located on Swingster Road, southeast of the intersection of Kansas Highway 32 and K-7. The plant consists of a pressure filter system targeting iron and magnesium removal with a total production rate of 900 to 1,000 gpm (1.28 to 1.42 MGD). This system does not have redundancy to meet current average day demands if one filter is offline. The utility has connections to the Board of Public Utilities (BPU) and an agreement to purchase additional water. Neither the existing plant or BPU produce softened water.

1.3 SCHEDULE

The following Table 1-1 is a summary of key project dates.

Table 1-1 Project Schedule

PROJECT MILESTONE OR TASK	DATE OR ANTICIPATED DURATION (MONTHS)
Submit Final Facility Report	May 2020
Prepare and Submit Final Design Bid Documents	February 2021 9 months
Regulatory Review	April 2021 2 months
Advertisement and Award	June 2021 2 months
Construction	June 2023 24 months

1.4 SITE DESCRIPTION

1.4.1 Location

The new WTP will be located east of the existing water treatment plant and utility buildings along Swingster Road. Source water will be supplied to the plant from four existing groundwater wells.

1.4.2 Datum

Elevations used on this project will be NAVD88 datum. Horizontal control will be based on the state plane coordinate system. Benchmarks for vertical and horizontal control will be established through a project survey.

1.5 APPLICABLE CODES, REGULATIONS, AND STANDARDS

1.5.1 Applicable Design Codes and Standards

The design of new facilities will be based on, but not limited to the following codes and standards.

- International Building Code (IBC), 2015 Edition
- International Mechanical Code (IMC), 2015 Edition
- International Plumbing Code (IPC), 2015 Edition
- International Fire Code (IFC), 2015 Edition
- National Electrical Code (NEC), 2014 Edition
- Kansas Department of Health and Environment (KDHE) Public Water Supply Section Design Standards 2008

1.5.2 Anticipated Permits

All applicable City and State Construction permits will be identified during design including but not limited to the following:

- Building
- Stormwater
- Wastewater
- Land disturbance
- Public works
- KDHE

1.6 GEOTECHNICAL AND SURVEY INFORMATION

1.6.1 Geotechnical

Black & Veatch retained the services of Geotechnology, Inc. as a subcontractor to perform preliminary field investigations, laboratory testing, and preliminary foundation design recommendations from a single boring in the vicinity of the new treatment plant Operations Building. Preliminary evaluations found fat clays at the site. Some mitigation will be required for foundations through soil replacement. No deep foundations are anticipated based on current weights and loadings facilities and structures. Reference Appendix D – Geotechnical Report for additional information. Additional geotechnical investigations should be conducted during detailed design to confirm conditions across the site and provide recommendations if required.

1.6.2 Survey

No survey was performed for this report. Completing a survey during detailed design is recommended to confirm site elevations at the location for the new plant and lime residual treatment facility.

1.7 DOCUMENTS

1.7.1 Drafting Standards

Electronic drawings will be produced using Revit and AutoCAD 2019. Black & Veatch Water standards, as modified by the Drafting Coordinator, will be implemented on the project. Review submittals at each detailed design milestone will be issued on standard (11-inch x 17-inch) "B" size sheets with Black & Veatch standard project border modified with project specific requirements. Upon completion, all final CAD drawings will be submitted on standard 22-inch by 34-inch sheets. Each sheet will bear the following general title:

City of Bonner Springs, Kansas
Water Treatment Plant

Design submittals and bid drawings will also be provided to the Owner in PDF format.

1.7.2 Specifications

Black and Veatch standard technical specifications and front end documents will be used and modified as required to suit the project. Standard front end documents (based on the Engineers Joint Contract Documents Committee) will be used.

1.7.3 References

The following reference materials will be referred to during design:

- A March 2019 report prepared for the City of Bonner Springs by Bartlett & West, titled "Water System Master Plan 2019 Update".
- A May 2020 report prepared for the City of Bonner Springs by Black & Veatch, titled "Water Supply Evaluation".
- A May 2020 report prepared for the prepared for the City of Bonner Springs by Black & Veatch, titled "Water Treatment Technology Evaluation".
- An April 2019 report prepared for the City of Bonner Springs by Geotechnology, Inc. titled "Preliminary Geotechnical Exploration Water Supply and Treatment Plant Study Bonner Springs, Kansas".

2.0 Process Design Criteria

The new WTP will be designed in accordance with the process design criteria described in this Chapter.

2.1 RAW WATER QUALITY

Raw water is sourced from several vertical wells drawing from the Kansas River Alluvial Aquifer. Water quality data on well water is limited and has been supplemented by water quality data from neighboring well fields. The groundwater contains high calcium and magnesium hardness and has significant levels of iron and manganese. Water quality used as the design basis is summarized in Table 2-1. Unless otherwise noted, the values shown in Table 2-1 were obtained from the City's *Water System Master Plan*, updated in March 2019.

Table 2-1 Raw Water Quality Summary

CONSTITUENT	MCL (SMCL)	AVERAGE VALUE
pH	(6.5 – 8.5)	7.2
Sodium, mg/L	-	68
Calcium[1], mg/L as $CaCO_3$	-	349
Magnesium, mg/L as $CaCO_3$	-	91
Total Hardness, mg/L as $CaCO_3$	-	440
Alkalinity, mg/L as $CaCO_3$	-	220
Chloride, mg/L	(250)	108
Sulfate, mg/L	(250)	195
Fluoride, mg/L	4 (2)	0.4
Nitrate, mg/L	10	0.4
TDS, mg/L	(500)	760
Iron, mg/L	(0.3)	0.2
Manganese, mg/L	(0.05)	2.0
Silica, mg/L	-	21
TOC[2], mg/L	-	1.79
HAA5s, µg/L (in finished water[1])	60	21
TTHMs, µg/L (in finished water[1])	80	45

CONSTITUENT	MCL (SMCL)	AVERAGE VALUE
Turbidity[2], mg/L	-	33

Notes:
1. Value from City of Bonner Springs 2017 Consumer Confidence Report.
2. Value from neighboring well field also on the Kansas River Alluvial Aquifer.

2.2 TREATED WATER GOALS

The primary treated water quality goal of this project is to produce finished water having a total hardness of 150 mg/L as CaCO3. This goal is consistent with the finished water hardness values of other local utilities.

Other water quality goals are to reduce the concentrations of constituents exceeding National Primary and Secondary Drinking Water Standards. Primary drinking water standards are enforceable while secondary drinking water standards are non-enforceable guidelines based on cosmetic or aesthetic effects. The only water quality constituents known to exceed the secondary drinking water standards at this time are manganese and total dissolved solids (TDS). Iron is included due to its tendency to coexist with manganese.

A final water quality goal is to produce finished water that is not corrosive to materials in the distribution system. This is generally achieved by ensuring the finished water conveyed to the distribution system will slightly promote scale formation. Metrics used to measure scale formation and corrosivity of water are the Langelier saturation index (LSI) and the calcium carbonate precipitation potential (CCPP). An LSI value between 0 and 1 and a CCPP value between 4 and 10 are indicative of water that is slightly, but not overly, scaling. Treated water quality goals for this project are summarized in Table 2-2.

Table 2-2 Treated Water Quality Goals

CONSTITUENT	GOAL
Total Hardness, mg/L as CaCO3	150
TDS, mg/L	< 500
Iron, mg/L	< 0.3
Manganese, mg/L	< 0.05
Langelier Saturation Index (LSI)	0 – 1
Calcium Carbonate Precipitation Potential (CCPP)	4 – 10

2.3 DESIGN PRODUCTION RATES

The new plant will be designed to produce a firm treatment capacity of 2.0 million gallons per day (MGD) when operated continuously with capability of turndown to demands as low as 0.40MGD. Provisions are included for the addition of another treatment train to expand the WTP to a firm capacity of 3.0 MGD in the future. Refer to Table 2-3 for summary of treatment plant production rates.

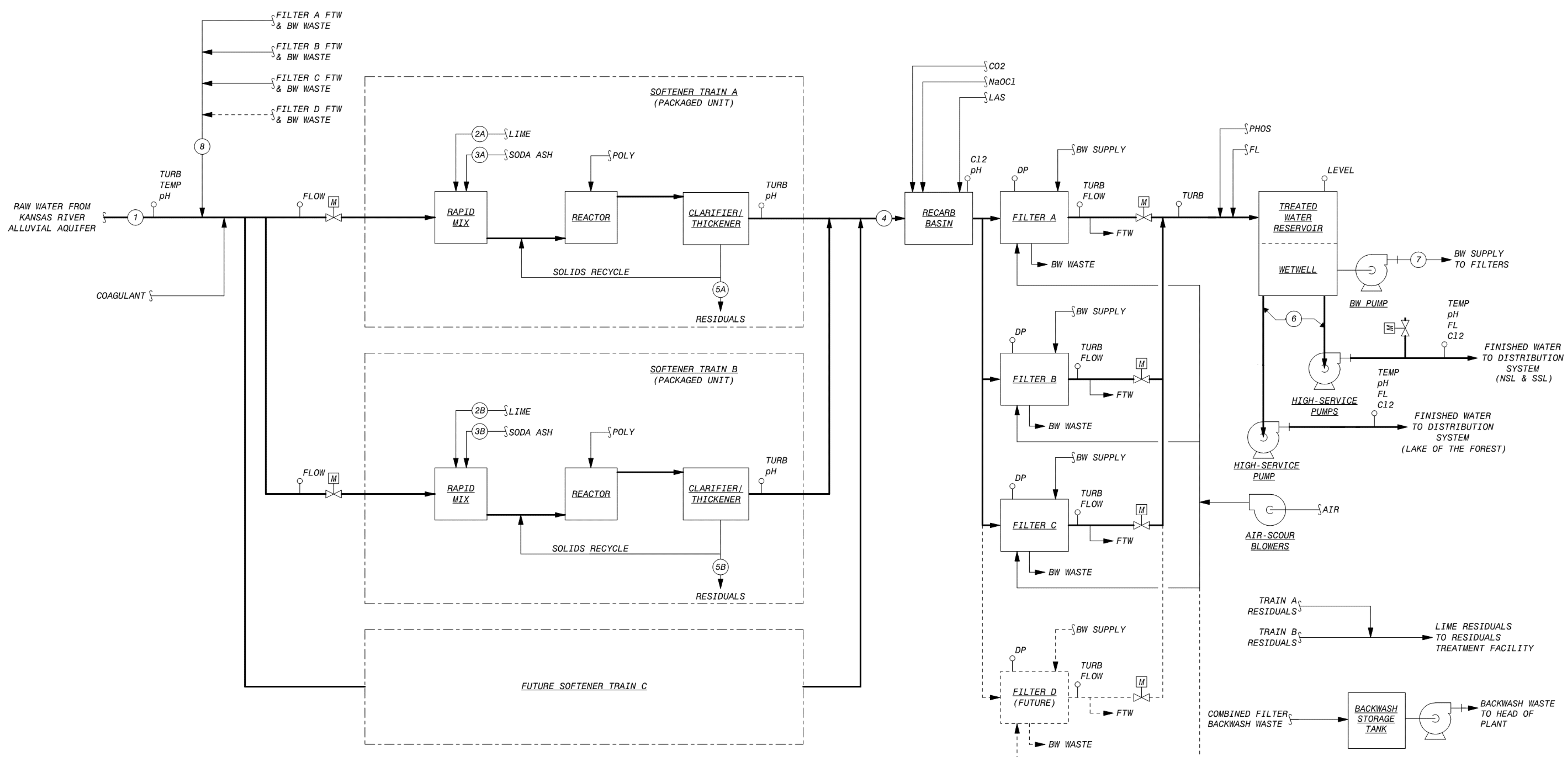
Table 2-3 Treatment Plant Production Rates

PRODUCTION DESIGN RATES	FLOW (MGD)
Minimum Production[1]	0.4
Average Production[2]	1.1
Peak, Firm Capacity	2.0
Future Peak, Firm Capacity	3.0

Notes:

1. Minimum production rate based on turndown capability for precipitative softening technology. Membrane softening technology is operated on an on/off basis and would lower production by running fewer hours in a day.
2. Value from 2019 Master Plan for year 2020

Reference Figure 2-1 and Figure 2-2 for the Process Flow Diagram and Hydraulic Profile respectively.



ABBREVIATIONS

BW	BACKWASH
COND	CONDUCTIVITY
Cl2	CHLORINE
CO2	CARBON DIOXIDE GAS
DP	DIFFERENTIAL PRESSURE
FL	FLUORIDE
FLOW	FLOW METER
FTW	FILTER-TO-WASTE
LAS	LIQUID AMMONIUM SULFATE
LIME	QUICKLIME/CALCIUM OXIDE
NaOCl	SODIUM HYPOCHLORITE
pH	pH CELL
PHOS	PHOSPHATE/POLYPHOSPHATE
POLY	POLYMER
TEMP	TEMPERATURE
TURB	TURBIDITY

STREAM	1	2A + 2B	3A + 3B	4	5A + 5B	6	7	8
DESCRIPTION	RAW WATER FROM WELLS	LIME	SODA ASH	SOFTENER EFFLUENT	LIME SLUDGE	FINISHED WATER	BACKWASH SUPPLY	BACKWASH WASTEWATER
FLOW, GPD	2,044,429	---	---	2,045,000	44,429	2,000,000	45,000	45,000
TDS, mg/L	808	---	---	489	489	489	489	489
SOLIDS, LB/DAY	842	3,105	1,954	768	11,119	---	---	768
% SOLIDS	0.005%	100%	100%	0.005%	3.00%	---	---	0.205%
CONTINUOUS/INTERMITTENT	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	INTERMITTENT	CONTINUOUS	INTERMITTENT	INTERMITTENT

PRELIMINARY - NOT FOR CONSTRUCTION

DATE | REVISIONS AND RECORD OF USE | NO. | BY | CHK | APP

BLACK & VEATCH
Black & Veatch Corporation
Kansas City, Missouri

CITY OF BONNER SPRINGS, KANSAS
WATER SUPPLY AND TREATMENT PLANT STUDY

FACILITY PLAN
PROCESS FLOW DIAGRAM

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

PROJECT NO.
404408

SHEET
OF

Figure 2-1 Process Flow Diagram

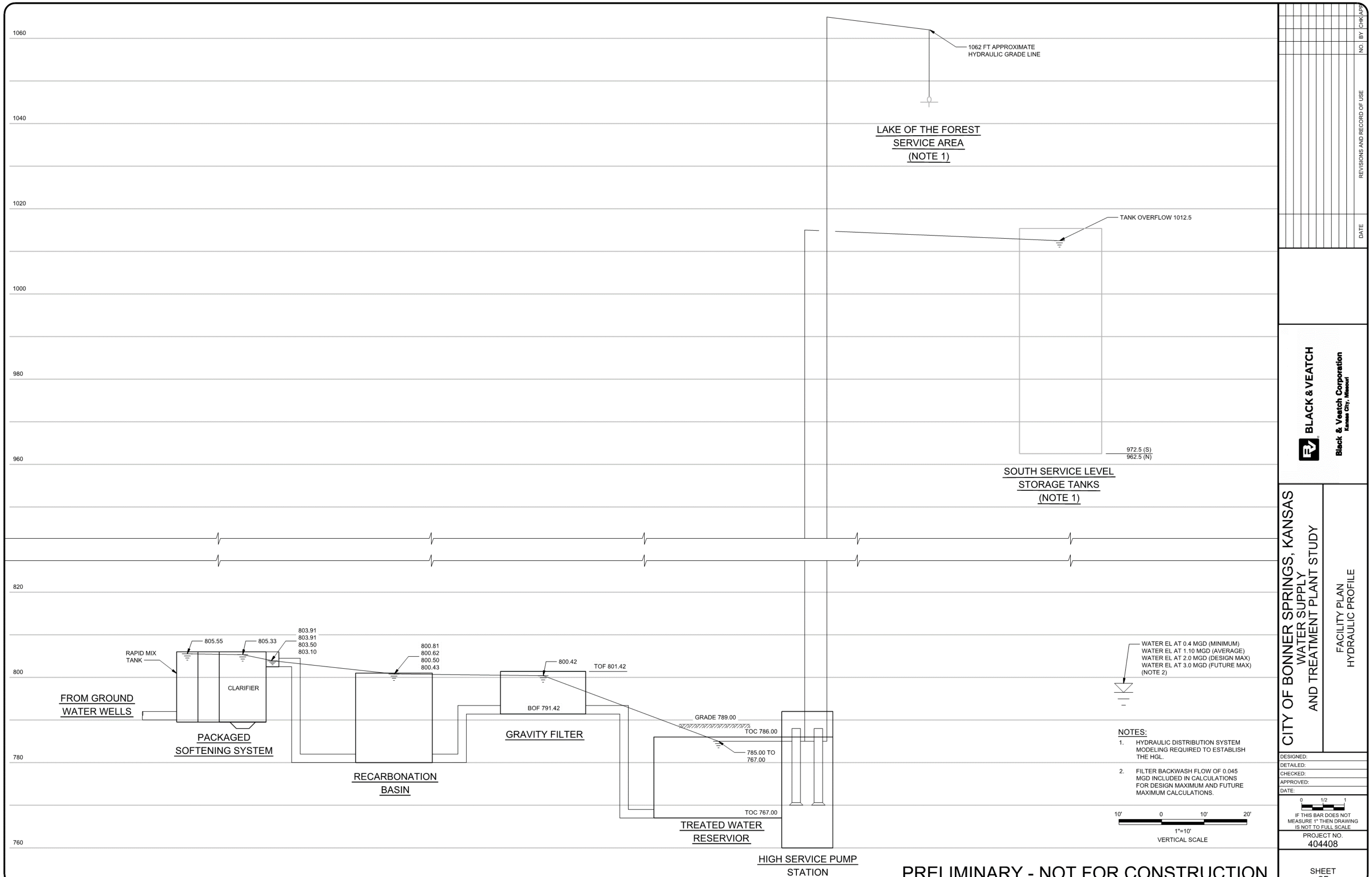


Figure 2-2 **Hydraulic Profile**

3.0 Treatment Facilities

3.1 HIGH-RATE PACKAGED CLARIFIER EQUIPMENT

High rate packaged clarifier units will be located on an exterior pad south of the new Operations Building. Flow will enter the system from the well field after flow metering. The high-rate precipitative softening equipment consists of packaged high-rate clarifier units with reactors and rapid mix basins. Lime and soda ash are fed into the rapid mix basin on each train from nearby packaged chemical feed systems. Coagulant is fed to the inlet of the treatment trains and polymer is fed to the reactor for optimization of the softening process. Table 3-1 includes preliminary details for the high rate clarifiers. Reference Figure 3-1 Site Plan for the location of the high rate packaged clarifier units.

Table 3-1 High-Rate Precipitative Softening Equipment Design Criteria

PARAMETER	DESIGN CRITERIA
High-Rate Clarifier Units	
Quantity	2 (1 duty, 1 standby)
Rated flow, MGD, each	2.0
Basin type	Coated carbon steel tanks
Clarifier loading rate, gpm/sf	7.7
Ancillary equipment	Mixers, residuals collector, residuals pumps, plates/tubes, collection troughs, instrumentation, controls

3.2 COAGULANT STORAGE AND FEED SYSTEM

A new coagulant (aluminum sulfate) storage and feed system will be located in the new Operations Building and will include totes, metering pumps, and appurtenances. Coagulant will be fed to the common header of the packaged high rate clarifier system. Reference Table 3-2 for design criteria of the new coagulant storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the coagulant storage and feed system.

Table 3-2 Coagulant Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	48.5% Aluminum Sulfate, SG = 1.335
Feed chemical, specific gravity (SG)	48.5% Aluminum Sulfate, SG = 1.335
Feed points	Influent header of packaged clarifier equipment
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2

PARAMETER	DESIGN CRITERIA
Chemical Dosage as Feed Chemical	
Average, mg/L	20
Maximum, mg/L	20
Chemical Feed Flow as Feed Chemical	
Average, gph	1.5
Maximum, gph	2.6
Aluminum Sulfate Storage	
Type	Tote
Quantity	4
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	1,320
Required storage for 30 days, gallons	1,112
Average storage, days (1)	36
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Aluminum Sulfate Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.03 to 2.6
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:

1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 1,900 gallons for 30 days of storage. One 2,500 gallon tank or six 330 gallon totes will be required for the future condition.

3.3 LIME STORAGE AND FEED SYSTEM

A new packaged lime storage and feed system will be located on an exterior pad located west of the packaged high-rate clarifiers. Lime will be fed to Rapid Mix Basin No.1 and Rapid Mix Basin No.2 of the high-rate clarifiers. Reference Table 3-3 for design criteria of the new lime storage and feed system. Reference Figure 3-1 Site Plan for the location of the lime storage and feed system.

Table 3-3 Lime Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, bulk density (BD)	90% Quick Lime, BD = 55 lb/ft3
Feed chemical, bulk density (BD)	90% Quick Lime, BD = 55 lb/ft3
Feed points	Rapid Mix Basin No. 1 Rapid Mix Basin No. 2
Plant Water Flow	
Average, MGD	1
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	217
Maximum, mg/L	217
Chemical Feed Flow as Feed Chemical	
Average, pph	84
Maximum, pph	168
Lime Storage	
Type	Silo
Quantity	2 (one per unit)
Materials	CS
Capacity, ft3, each	1,150
Total storage, ft3	2,300
Required storage for 30 days, gallons	1,100
Average storage, days (1)	62
Dimensions	
Diameter, feet	12
Straight side height, feet	10
Cone height, feet	9

PARAMETER	DESIGN CRITERIA
Lime Feeder	
Quantity	2 (one per unit)
Type	Rotary Vane Feeder
Capacity, pph	250
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Lime Detention Slaker	
Quantity	2 (one per unit)
Type	Vertical Cylindrical
Materials	SS
Capacity, pph	250
Lime Grit Remover	
Quantity	2 (one per unit)
Type	Screw
Motor, hp	1/3
Lime Slurry Tank	
Quantity	2 (one per unit)
Type	Vertical Cylindrical
Materials	SS
Capacity, gal	500
Lime Slurry Feed Pumps	
Quantity	4 (two per unit)
Type	Horizontal Centrifugal
Capacity, gpm	70
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	CS
Valve Type	Ball/Pinch
Notes: 1. Days of storage based on total storage.	

3.4 SODA ASH STORAGE AND FEED SYSTEM

A new packaged soda ash storage and feed system will be located on an exterior pad west of the packaged high rate clarifier system. Soda ash will be fed to Rapid Mix Basin No.1 and Rapid Mix Basin No.2. Reference Table 3-4 for design criteria of the new soda ash storage and feed system. Reference Figure 3-1 Site Plan for the location of the soda ash storage and feed system.

Table 3-4 Soda Ash Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, bulk density (BD)	99% Soda Ash, BD = 65 lb/ft3
Feed chemical, bulk density (BD)	99% Soda Ash, BD = 65 lb/ft3
Feed points	Rapid Mix Basin No. 1 Rapid Mix Basin No. 2
Plant Water Flow	
Average, MGD	1
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	140
Maximum, mg/L	140
Chemical Feed Flow as Feed Chemical	
Average, pph	76
Maximum, pph	153
Soda Ash Storage	
Type	Silo
Quantity	1
Materials	CS
Capacity, ft3, each	1,000
Total storage, ft3	1,000
Required storage for 30 days, gallons	850
Average storage, days (1)	35
Dimensions	
Diameter, feet	12
Straight side height, feet	8
Cone height, feet	9

PARAMETER	DESIGN CRITERIA
Soda Ash Feeder	
Quantity	1
Type	Volumetric Screw
Capacity range, pph	9.8 to 98
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Soda Ash Solution Tank	
Quantity	1
Type	Vertical Cylindrical
Materials	SS
Capacity range, gal	500
Soda Ash Solution Feed Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Centrifugal
Capacity, gpm	50
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	CS
Valve Type	Ball
Notes: 1. Days of storage based on total storage.	

3.5 POLYMER STORAGE AND FEED SYSTEM

A new polymer storage and feed system will be located in the new Operations Building and will include a tote, metering pumps, and appurtenances. Polymer will be fed to Reactor No. 1 and Reactor No. 2 of the high-rate clarifiers. Reference Table 3-5 for design criteria of the new polymer storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the polymer storage and feed system.

Table 3-5 Polymer Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	35% Active Polymer, SG = 1.02
Feed chemical, specific gravity (SG)	35% Active Polymer, SG = 1.02
Feed points	Reactor No. 1 Reactor No. 2
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	1
Maximum, mg/L	1
Chemical Feed Flow as Feed Chemical	
Average, gph	0.14
Maximum, gph	0.24
Polymer Storage	
Type	Tote
Quantity	1
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	101
Average storage, days (1)	98
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Polymer Metering Pumps	
Quantity	3 (2 duty + 1 standby)
Type	Diaphragm
Capacity range, gph (2)	0.01 to 0.24
Turndown ratio, per pump	40:1

PARAMETER	DESIGN CRITERIA
Control	Automatic and manual start/stop. Automatic and manual stroke length and stroke speed control with local override.
Pipe Material	PVC
Valve Type	Ball
Notes: 1. Days of storage based on total storage. 2. Minimum metering pump capacity is based on pump turndown. 3. Future 2 MGD average plant flow will require 170 gallons for 30 days of storage. One 330 gallon tote will be required for the future condition.	

3.6 RECARBONATION EQUIPMENT

A recarbonation system is provided to reduce the pH and to form bicarbonate alkalinity to stabilize the softened water, such that the LSI and CCPP values are within the established treated water goals. The recarbonation system will consist of a concrete basin-style contactor with baffles, a carbon dioxide feed system, a carbon dioxide storage tank and appurtenances. The basin will include a mixing chamber with 3 minute retention time. The remainder of the basin will have a minimum of 17 minute retention time for a total retention time of 20 minutes. The feed system and storage tank will be located on an exterior pad adjacent to the contactor basin. Carbon dioxide will be fed as carbonic acid to the feed point. Table 3-6 includes preliminary design criteria for the recarbonation equipment. Reference Figure 3-1 Site Plan for the location of the recarbonation system.

Table 3-6 Recarbonation Equipment Design Criteria

PARAMETER	DESIGN CRITERIA
Carbon Dioxide Contactor	
Quantity	1 x 100%
Rated flow, MGD, each	3.0
Basin type	Concrete basin with baffles
Hydraulic retention time (HRT), min	20
Basin volume, gal	42,600
Basin side water depth, ft	20
Chemical Information	
Delivered chemical, specific volume (SV)	100% CO2, SV = 8.77 ft3/lb (0.11 lb/ft3)
Feed chemical, specific gravity (SG)	100% CO2, SV = 8.77 ft3/lb (0.11 lb/ft3)
Feed point	Recarbonation Basin
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2

PARAMETER	DESIGN CRITERIA
Chemical Dosage as Feed Chemical	
Average, mg/L	15.39
Maximum, mg/L	15.39
Chemical Feed Flow as Feed Chemical	
Average, ppd	129
Maximum, ppd	257
CO2 Storage	
Type	Tank
Quantity	1
Materials	SS
Capacity, tons, each	6
Total storage, tons	6
Required storage for 30 days, tons	2
Average storage, days (1)	46
Dimensions	
Length, feet	16
Width, feet	6
Height, feet	6
Carbonic Acid Feeders	
Quantity	2 (1 duty + 1 standby)
Capacity range, ppd(2)	25.7 to 257
Turndown ratio, per pump	10:1
Control	Automatic and manual start/stop.
Pipe Material	CS/PVC
Valve Type	Ball

Notes:

1. Days of storage based on total storage.
2. Minimum feeder capacity is based on feeder turndown.
3. Future 2 MGD average plant flow will require 7,700 lbs for 30 days of storage. One 6 ton tank will be required for the future condition.

3.7 DISINFECTION EQUIPMENT

Primary disinfection will be accomplished through feed of sodium hypochlorite for free chlorine contact. Sodium hypochlorite will be fed to the inlet of the recarbonation process which will be used simultaneously for primary disinfection. Sufficient contact time will be provided in the contactor to achieve 4-log virus inactivation. Following primary disinfection, liquid ammonium sulfate (LAS) will be added to form chloramines for secondary disinfection. The preliminary feed location for LAS is at the end of the recarbonation basin. The actual location will be determined during final design after input from KDHE. Sodium hypochlorite and LAS storage and feed systems will be located in the new Operations Building and will include totes, metering pumps, and appurtenances. Details for disinfection systems are provided in Table 3-7 and Table 3-8 for sodium hypochlorite and LAS respectively. Reference Figure 3-2 for the new Operations Building plan for the layout of the sodium hypochlorite and LAS storage and feed systems.

Table 3-7 Sodium Hypochlorite Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	12.5% Sodium Hypochlorite, SG = 1.175 (1.04 lbs Cl_2/gallon solution)
Feed chemical, Specific gravity (SG)	12.5% Sodium Hypochlorite, SG = 1.175 (1.04 lbs Cl_2/gallon solution) 10% Sodium Hypochlorite, SG = 1.142 (0.73 lbs Cl_2/gallon solution)
Feed point	Recarbonation Basin (inlet)
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as 100% Chlorine	
Average, mg/L	3
Maximum, mg/L	3
Chemical Feed Flow as 12.5% Sodium Hypochlorite	
Average, gph	1.2
Maximum, gph	2
Chemical feed flow as 10% Sodium Hypochlorite	
Average, gph	1.5
Maximum, gph	2.5
Sodium Hypochlorite Storage	
Type	Tote
Quantity	3
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	990
Required storage for 30 days, gallons	865

PARAMETER	DESIGN CRITERIA
Average storage, days [1]	34
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Sodium Hypochlorite Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph [2]	0.03 to 2.5
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override
Pipe Material	CPVC
Valve Type	Vented Ball
Pipe Material in Duct Bank	Teflon Tubing

Notes:

1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown. Maximum metering pump capacity is based on feeding 10% sodium hypochlorite due to degradation.
3. Future 2 MGD average plant flow will require 1,450 gallons for 30 days of storage. One 1,600 gallon tank or six 330 gallon totes will be required for the future condition.

Table 3-8 Liquid Ammonium Sulfate Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	40% Liquid Ammonium Sulfate, SG = 1.228
Feed chemical, specific gravity (SG)	40% Liquid Ammonium Sulfate, SG = 1.228
Feed point	Recarbonation Basin (effluent)
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as 100% LAS	
Average, mg/L	3.54

PARAMETER	DESIGN CRITERIA
Maximum, mg/L	3.54
Chemical Feed Flow as Feed Chemical	
Average, gph	0.36
Maximum, gph	0.6
LAS Sulfate Storage	
Type	Tote
Quantity	1
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	260
Average storage, days (1)	38
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
LAS Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.006 to 0.6
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball

Notes:

1. Days of storage based on total storage.
2. Minimum metering pump capacity is based on pump turndown.
3. Future 2 MGD average plant flow will require 433 gallons for 30 days of storage. Two 330 gallon totes will be required for the future condition.

3.8 FILTRATION EQUIPMENT

Gravity filters are located in the new Operations Building downstream of the softening and recarbonation processes to remove any solids remaining in the softened water. To minimize footprint, packaged dual media filters containing sand and anthracite will be provided, which can operate at a maximum of 4.0 gpm/sf per KDHE Minimum Design Standards. Higher loading rates may be allowed after a period of successful operation. The filters will be equipped with an air-scour blower. A backwash system is required for proper filter operation. Details for the gravity filters are included in Table 3-9. Reference Figure 3-2 for the new Operations Building plan for the layout of the gravity filters.

Table 3-9 Gravity Filter Equipment Design Criteria

PARAMETER	DESIGN CRITERIA
Gravity Filters	
Quantity	3 (2 duty, 1 standby)
Rated flow, MGD, each	1.0
Type	Packaged, dual media, gravity filters
Loading rate, gpm/sf	4.0
Filter area, sf	175
Media	18 inches of 1.0 mm anthracite 12 inches of 0.5 mm sand
Air-scour blower	1 duty, 20 hp
Ancillary equipment	Front piping, valves, instrumentation and controls

A backwash feed pump (1 duty) will be housed in the High Service Pump station, feeding water from the Treated Water Reservoir back to the filters. There will be an emergency interconnection with the high service pumps discharge so that the high service pumps can serve as a backup. The connection will have a flow regulating valve to accommodate the differences in pressure required. After the filter backwash cycle is complete, backwash water will flow by gravity to the Backwash Storage Tank. The Backwash Storage Tank will be a circular concrete tank located below grade. A backwash filter return pumping system will be constructed integral to the tank to send backwash back to the head of the plant at a rate no more than 10% of plant flow. Details for the Backwash system are included in Table 3-10. Reference Figure 3-1 Site Plan for the location of the Backwash Storage Tank and Pump Station and the High Service Pump Station.

Table 3-10 Backwash System Design Criteria

PARAMETER	DESIGN CRITERIA
Backwash Feed Pump	
Quantity	1
Rated flow, MGD	6.3
Type	Vertical turbine
Hp	60
Backwash Storage Tank	
Type	Circular
Volume, gal	84,520

Diameter, ft	27
Depth	20
Backwash Filter Return Pumps	
Quantity	1 duty, 1 standby
Rated flow, MGD, each	0.3 (10% of influent plant flow)
Type	Submersible
Drive	Adjustable frequency drive
Hp	15

3.9 FLUORIDE STORAGE AND FEED SYSTEM

A new fluoride (hydrofluosilicic acid) storage and feed system will be located in the new Operations Building and will include totes, metering pumps, day tank and appurtenances. Fluoride will be fed downstream of the filters prior to the treated water reservoir. Fluoride will be fed for the benefit of dental and skeletal health. Reference Table 3-11 for design criteria of the new fluoride storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the fluoride storage and feed system.

Table 3-11 Fluoride Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	24% Hydrofluosilicic Acid, SG = 1.211
Feed chemical, specific gravity (SG)	24% Fluorine, SG = 1.211
Feed point	Pre- Treated Water Reservoir
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	1.27
Maximum, mg/L	1.27
Chemical Feed Flow as Feed Chemical	
Average, gph	0.22
Maximum, gph	0.37
Fluoride Storage	
Type	Tote
Quantity	1
Materials	HDPE

PARAMETER	DESIGN CRITERIA
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	156
Average storage, days (1)	62
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Fluoride Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.004 to 0.37
Turndown ratio, per pump	100:1
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball
Notes: 1. Days of storage based on total storage. 2. Minimum metering pump capacity is based on pump turndown. 3. Future 2 MGD average plant flow will require 260 gallons for 30 days of storage. One 330 gallon tote will be required for the future condition.	

3.10 PHOSPHATE STORAGE AND FEED SYSTEM

A new phosphate storage and feed system will be located in the new Operations Building and will include a tote, metering pumps, and appurtenances. The preliminary location of the phosphate feed will be downstream of the filters prior to the Treated Water Reservoir. Preliminarily, orthophosphate has been used for the basis of design. Final selection of a phosphate chemical (orthophosphate, polyphosphate, or blend) and feed location will be determined during detailed design after discussion with KDHE and, potentially, a pipe loop study. A pipe loop study may be required to determine the dose and type of corrosion inhibitor to protect the distribution system from corrosion. Reference Table 3-12 for design criteria of the new phosphate storage and feed system. Reference Figure 3-2 for the new Operations Building plan for the layout of the phosphate storage and feed system.

Table 3-12 Phosphate Storage & Feed System Design Criteria

PARAMETER	DESIGN CRITERIA
Chemical Information	
Delivered chemical, specific gravity (SG)	100% Zinc Orthophosphate, SG = 1.34
Feed chemical, specific gravity (SG)	100% Zinc Orthophosphate, SG = 1.34
Feed point	Pre- Treated Water Reservoir
Plant Water Flow	
Average, MGD	1.2
Maximum, MGD	2
Chemical Dosage as Feed Chemical	
Average, mg/L	3
Maximum, mg/L	3
Chemical Feed Flow as Feed Chemical	
Average, gph	0.12
Maximum, gph	0.186
Phosphate Storage	
Type	Tote
Quantity	1
Materials	HDPE
Capacity, gallons, each	330
Total storage, gallons	330
Required storage for 30 days, gallons	81
Average storage, days (1)	114
Dimensions	
Length, feet	4
Width, feet	4
Height, feet	4
Phosphate Metering Pumps	
Quantity	2 (1 duty + 1 standby)
Type	Tube type peristaltic metering pump
Capacity range, gph (2)	0.002 to 0.186
Turndown ratio, per pump	100:1

PARAMETER	DESIGN CRITERIA
Control	Automatic and manual start/stop. Automatic and manual speed control with local override.
Pipe Material	PVC
Valve Type	Ball
Notes: 1. Days of storage based on total storage. 2. Minimum metering pump capacity is based on pump turndown. 3. Future 2 MGD average plant flow will require 134 gallons for 30 days of storage. One 330 gallon tote will be required for the future condition.	

3.11 TREATED WATER RESERVOIR

A below grade concrete Treated Water Storage Tank will located on the north side of the site. The reservoir will be constructed for ease of expansion in the future. The west end of the basin will be sized with a depth to act as a wetwell for the high service pumps. Reservoir will be designed with stub walls to allow for easier expansion of the tank for future conditions. Reference Table 3-13 for design criteria for the new Treated Water Reservoir. Reference Figure 3-1 Site Plan to see the proposed location for the new Treated Water Reservoir.

Table 3-13 Treated Water Reservoir Design Criteria

PARAMETER	DESIGN CRITERIA
Treated Water Reservoir	
Quantity	1
Type	Baffled concrete basin, below grade
Storage capacity, gal	239,350
Dimensions	
Length, ft	40
Channel width, ft	20
Side water depth, ft	18

3.12 HIGH SERVICE PUMP STATION

A High service Pump station will be located above the Treated Water Reservoir. The west end of the basin will be sized with a depth to act as a wetwell for the high service pumps. Pump station will include 3 pumps for distribution to the north and south service levels (2 duty, 1 standby), a single pump for the Lake of the Forest service area and a backwash feed pump. Reference Table 3-14 for design criteria for the new High Service Pump Station. Pumps will be valved such that the standby pump is available for the north and south service levels and the Lake of the Forest service area. Reference Figure 3-1 Site Plan to see the proposed location for the new high service pump station.

Table 3-14 High Service Pump Station Design Criteria

PARAMETER	DESIGN CRITERIA
High Service Pumps	
Feed Location	South Service Level Storage Tanks
Quantity	3 (2 duty, 1 standby)
Rated flow, MGD, each	1
Min flow, MGD, each	0.3
Type	Vertical turbine
Drive	Adjustable frequency drive
Hp	100
Feed Location	Lake of the Forest
Quantity	1
Rated flow, MGD	0.1
Min flow, MGD	0.04
Type	Vertical turbine
Drive	Adjustable frequency drive
Hp	15

3.13 LIME RESIDUAL TREATMENT FACILITY

A Lime Residual Treatment Facility (LRTF) will be provided for treatment of lime residuals from the high-rate clarification process. The LRTF will allow for percolation of supernatant and landfill or land application for disposal of residuals. Reference Table 3-15 for design criteria for the new LRTF. Reference Figure 3-1 Site Plan to see the proposed location for the new LRTF.

Table 3-15 Lime Residual Treatment Facility Design Criteria

PARAMETER	DESIGN CRITERIA
Lime Residual Treatment Facility	
Quantity	1
Type	Earthen lagoon
Storage capacity, MG (cf)	41.89 (560,000)
Dimensions	
Length, ft	175
Width, ft	160
Depth, ft	20
Storage at 1.5 MGD plant production rate, years	5.2

3.14 SITEWORK AND UTILITIES

3.14.1 Plant Roadways

Access roads to the plant from Swingster Road and around major buildings and structures will be provided. Parking will be provided on the west side of the new Operations Building. An access road will be provided at the new Lime Residual Treatment Facility connecting to existing nearby groundwater well access roads. Pavement will be asphalt. Roads will have two 12-foot travel lanes. Reference Figure 3-1 Site Plan for road work.

3.14.2 Sanitary Drainage

A new sanitary sewer system will be established across the plant to collect sanitary drainage from the new Operations Building. Drainage will be collected for restrooms, sinks, combination eyewash/shower systems and service water hose faucets and floor drains. Chemical storage rooms will not be connected to the sanitary drainage system but will have collection trenches and sumps for removal of any spilled chemicals and washdown water. The Treated Water Reservoir and Backwash Storage Tank will be drained as needed to their respective service feed points and will not be connected to the sanitary drain system. The Recarbonation Basin will be evaluated during design on whether it may be tied directly to the new sanitary system or be drained by pumping. Connection to nearby collection systems will be evaluated during detailed design.

3.14.3 Storm Drainage

A new plant storm water system will be established across the site. Stormwater will be routed and collected to earthen swales with culverts below roadways as necessary. Storm water system design will be based on the City of Bonner Springs requirements. Additional mitigation requirements for stormwater drainage off-site will be evaluated during detailed design.

3.14.4 Potable Water System

Potable water will be fed from the discharge of the high service pumps to establish a plant-wide distribution system. The potable water system will be connected to the Operations Building for fire protection, sinks, bathrooms, wall hydrants etc. Nonpotable services will be located downstream of a backflow preventer. The system will feed fire hydrants (to be located during design) around the site and any yard hydrants necessary for cleaning and maintenance.

3.14.5 Process Piping

Process yard piping between buildings will consist of ductile iron pipe. Chemical systems will be routed through chemical duct banks including carrier pipe and concrete encasement. Where chemical piping is required to be routed above grade, it will be insulated and heat traced to protect from freezing. Piping material will be as defined within the respective chemical paragraphs.

3.14.6 Electricity

A new utility service connection will be required and will be coordinated and provided by the electric utility (Evergy). A backup natural gas generator will be provided for backup power. See Chapter 7 Electrical Design criteria for additional detail.

3.14.7 Natural Gas

Natural gas will be brought to the site for backup power generation purposes. See Chapter 7 Electrical Design criteria for additional detail on the backup power generator. Requirements to connect to nearby gas mains will be evaluated during design.

3.14.8 Lake of the Forest Connection

A new 6-inch PVC interconnection to the Lake of the Forest service area will be required (approximately 9,490 linear feet). The service area will have a dedicated high service pump and tie into the existing distribution system near 8th Street. And Lake Forest Road. Additional evaluation of new pipe size and connection to the existing distribution system will be required during detailed design.

Figure 3-1 **Site Plan**

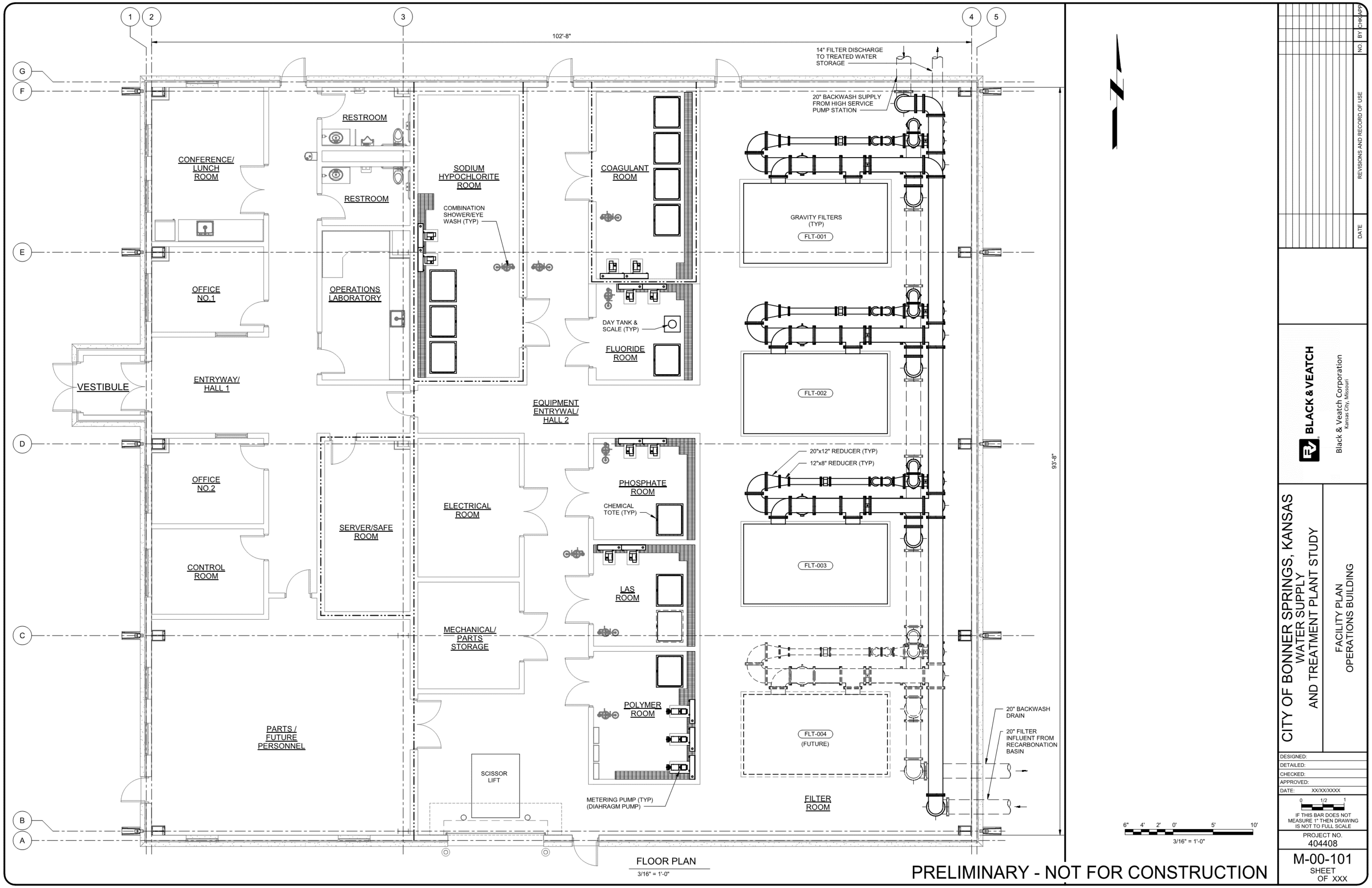


Figure 3-2 Operations Building Layout

4.0 Architectural Design Criteria

4.1 APPLICABLE STANDARDS AND GENERAL REQUIREMENTS

The architectural design will conform to the following codes:

- International Building Code (IBC), 2015 Edition
- International Existing Building Code (IEBC), 2015 Edition
- International Fire Code (IFC), 2015 Edition

The new Operations Building and other facilities at the new Water Treatment Plant will meet the following code requirements of the International Building Code and the International Existing Building Code, respectively:

Table 4-1 Operations Building – Building Code Analysis

OPERATIONS BUILDING	
Occupancy	Mixed Occupancy – Groups F-2 and H-4
Type of Construction	II-B
Allowable Building Area	17,500 SF per story
Actual Building Area	9,880 SF
Allowable Building Height	2 stories (55 ft)
Design Occupant Loads	100 sf/person (industrial) 300 sf/person (electrical & mechanical equipment rooms)
Means of Egress	2 minimum or maximum 75ft travel distance
Accessibility	Administrative areas only. Not required in equipment spaces (IBC 1103.2.9)
Fire Separation	2-Hour fire rated barriers between F-2 and H-4; around Electrical Room; around chemical rooms as required.
Fire Sprinklers	Yes, Sodium Hypochlorite & Coagulant rooms only

4.2 ARCHITECTURAL DESIGN CONSIDERATIONS

The building shell will be a pre-engineered metal building (PEMB). The interior will consist of two areas – a high open process area and an administrative/office area. Chemicals and chemical operations will be separated as required for safety. There will be toilets, breakroom/conference area, offices, and control room. Reference Figure 3-2 for the Operations Building layout.

There will be a server room with fire protection and space to hold personnel for extra protection in the event of a storm. This area will not be designed and constructed as an ICC 500 Storm Shelter.

4.2.1 Wall Construction

Exterior walls will be PEMB pre-finished corrugated metal panel. Insulation will be vinyl faced batt insulation. In process areas, metal liner panel will be installed to a minimum height of 8'-0". In office areas, there will be metal liner panel to the ceiling or painted gypsum wallboard.

For appearance and durability, a masonry wainscot will be used at the exterior base of wall. The aesthetics of the building can be further enhanced by selecting wall, roof, and trim colors for a distinctive look during detailed design.

Interior walls will be concrete masonry units (CMU) covered with paint or coatings appropriate for the use of the room. Certain chemicals will be isolated within fire-rated enclosures. Administrative walls may be furred and covered with painted gypsum wallboard.

4.2.2 Roof Construction

The roof will be PEMB pre-finished corrugated metal panel. Insulation will be vinyl faced batt insulation, exposed on the process side.

4.2.3 Ceiling Construction

The administrative side of the building will have acoustical tile ceilings. Fire-rated rooms will have a concrete ceiling.

4.2.4 Floor Construction

Flooring will be sealed concrete in the process area; vinyl tile in the breakroom and hallway; ceramic tile in the toilets, carpet in the offices and control room; and anti-static flooring in the server room. Chemical rooms will have a chemical resistant protective coating on the floors and partway up the walls.

4.2.5 Building Openings

There will be a rolling aluminum door for large equipment and walk doors for personnel. Double doors with an inactive leaf will be used at rooms requiring larger openings for movement of materials. Swinging doors and frames will be FRP.

Administrative areas will have view windows and process areas will have high windows for natural lighting. Glazing will be insulated and low-E.

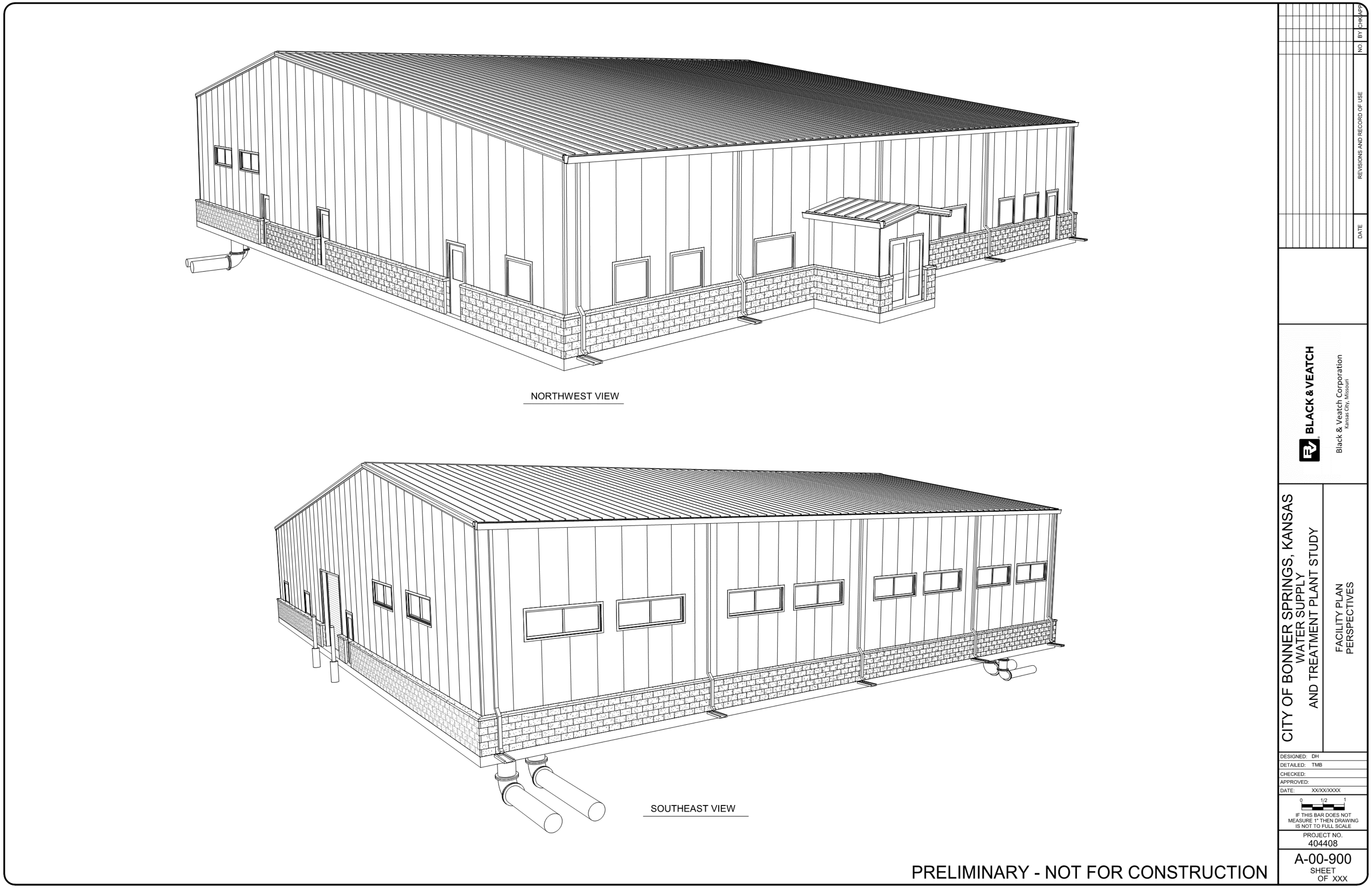


Figure 4-1 Operations Building Perspectives

5.0 Structural Design Criteria

5.1 GENERAL

This structural design criterion establishes the minimum design requirements for buildings, environmental and liquid containing structures, yard structures, miscellaneous equipment foundations, non-structural components, piping supports, and other miscellaneous items requiring structural design.

5.2 APPLICABLE CODES, STANDARDS, AND REFERENCES

The codes, standards, and references listed below will serve as the basis for structural design.

- International Building Code (IBC), 2015 Edition.
- ASCE 7-10: Minimum Design Loads for Buildings and Structures.
- Preliminary Geotechnical Exploration, Water Supply and Treatment Study, 12401 Kaw Drive, Bonner Springs, Kansas by Geotechnology, Inc.
- ACI 318-14: Building Code Requirements for Structural Concrete.
- ACI 350-06: Code Requirements for Environmental Engineering Concrete Structures and Commentary ACI 350R-06.
- ACI 350.3-06: Seismic Design of Liquid Containing Structures and Commentary ACI 350.3R-06.
- ACI 530-13: Building Code Requirements for Masonry Structures.
- Aluminum Design Manual, 2015 Edition.
- AISC Manual of Steel Construction, 14th Edition.
- AISC 360: Specification for Structural Steel Buildings 2010.
- PCI MNL 120-10: PCI Design Handbook, Precast and Prestressed Concrete, 7th Edition.

5.3 SPECIFIED MATERIAL PROPERTIES

5.3.1 Concrete

- Cast-in-Place Structural Concrete

    Flatwork, mortar puddle, and drilled piers: f'_c = 4,000 psi

    Environmental structures: f'_c = 4,500 psi

    Other structures: f'_c = 4,500 psi

- Prestressed/Precast Structural Concrete: f'c = 5,000 psi
- Nonstructural Concrete (Concrete fill, duct banks, pipe blocking, pipe encasement): f'_c = 3,000 psi

5.3.2 Concrete and Masonry Reinforcement

- Reinforcing Bars (ASTM A615 or ASTM A706): fy = 60,000 psi

■ Welded Wire Mesh (ASTM A1064):	fy = 70,000 psi

5.3.3 Masonry

■ Masonry unit assembly:	f'm = 2,500 psi

5.3.4 Structural Steel

■ W and WT shapes (ASTM A992, Grade 50):	fy = 50,000 psi
■ M, S, C and MC shapes (ASTM A36):	fy = 36,000 psi
■ Angles, bars, plates, and other structural shapes (ASTM A36):	fy = 36,000 psi
■ HP shapes (ASTM A572, Grade 50):	fy = 50,000 psi
■ Pipe sections (ASTM A53, Type E or S, Grade B):	fy = 35,000 psi
■ Round Structural Tube sections (ASTM A500, Grade C):	fy = 46,000 psi
■ Square and Rectangular Tube sections (ASTM A500, Grade C):	fy = 50,000 psi
■ Weld materials (ANSI/AWS D1.1, Table 3.1), using E70XX filler metal with minimum tensile strength:	Fw = 70 ksi
■ High strength bolts (ASTM F3125, Grade A325, Type 1 or Grade F1852 Twist-Off/TC, Type 1) tensile strength:	Fu = 120 ksi

5.3.5 Aluminum

- Aluminum Association standard shapes (ASTM B308, Alloy 6061-T6)
- Sheet and Plate (ASTM B209, Alloy 6061-T6)
- Material strengths for all aluminum materials:

Tensile yield strength:	F_{ty} = 35,000 psi
Compressive yield strength:	F_{cy} = 35,000 psi
Shear yield strength:	F_{sy} = 20,000 psi

5.4 LOADING CRITERIA

5.4.1 Dead Loads

Dead load will include the weight of all permanent construction, including roofs, walls, floors, partitions, interior finishes, fixed equipment, tanks and bins including contents, equipment bases, pipes, HVAC ducting, and electrical lighting. Dead load criteria are indicated in Table 5-1.

Table 5-1 Dead Load Criteria

PARAMETER	CRITERIA
Equipment, tanks, silos, etc.	Actual weights
Pipe, 12 inch diameter and smaller	25 psf over full member length
Pipe, 14 inch diameter and larger	Actual weights
Phantom load	2 kips on primary beams, 1 kip on secondary beams, 300 lbs on steel joists
Concrete (normal weight)	150 pcf
Roofing and rigid insulation board	Actual, 15 psf (minimum)
HVAC ductwork (general)	5 psf
Lighting (general)	3 psf

5.4.2 Live Loads (Floor and Roof)

A minimum floor live load of 150 psf will be applicable to all operating floors. For large equipment areas, the combined weight of equipment and concrete pad plus an additional live load of 50 psf over the base area may be used as the live load. The equipment weight may be assumed distributed over an area 3'-0" all around beyond the concrete pad perimeter. Additional live load criteria are indicated in Table 5-2.

Table 5-2 Live Load Criteria

PARAMETER	CRITERIA
Operating floors	150 psf
Walkways, stairs and landings	100 psf
Elevated equipment platforms (non-egress)	60 psf
Storage, general	250 psf
Control room floors	250 psf
Ordinary roof live load	20 psf minimum (no reduction taken)

5.4.3 Snow Loads

Snow loads will be determined in accordance with IBC Section 1608 in conjunction with ASCE 7, Chapter 7. Drifting snow, unbalanced snow and rain-on-snow surcharge will be considered. Basic snow load parameters are given in Table 5-3.

Table 5-3 Snow Load Criteria

PARAMETER	CRITERIA
Minimum Ground Snow Load	20 psf
Terrain Category	C
Importance Factor	1.1
Exposure Factor, C_e	1.0
Thermal Factor, C_t	1.1

5.4.4 Wind Loads

Wind loads will be determined for primary frames and components of structures in accordance with IBC Section 1609 in conjunction with ASCE 7, Chapter 26. ASCE7, Chapter 28 (Wind Loads on Buildings – MWFRS) will be used for low-rise buildings meeting the scope requirements of Section 28.1.1. For other structures, ASCE 7, Chapter 29 (Wind Loads on Other Structures and Building Appurtenances – MWFRS) will apply. ASCE 7, Chapter 30 will be applied to components and cladding. Basic wind load parameters are given in Table 5-4.

Table 5-4 Wind Load Criteria

PARAMETER	CRITERIA
Risk Category	III
Basic Wind Speed	120 mph
Exposure Category	Exposure C

5.4.5 Seismic Loads

Seismic loads will be determined for primary frames and components of building structures in accordance with IBC Section 1613 in conjunction with ASCE 7, Chapter 11. ASCE 7, Chapter 12 will be the basis of design for buildings and similar structures. Non-structural components will be designed for the seismic loads indicated in ASCE 7, Chapter 13. Non-building structures will be designed for the seismic loads indicated in ASCE 7, Chapter 15. Liquid-containing concrete structures will be designed for the seismic loads indicated in ACI 350.3. Interior walls and partitions will be designed for a minimum of 10 psf lateral pressure (strength-level). Basic seismic load parameters are given in Table 5-5.

Table 5-5 Seismic Load Criteria

PARAMETER	CRITERIA
Short period spectral acceleration, (S_s)	0.112
One second period spectral acceleration, (S_1)	0.062
Risk Category	III
Seismic Design Category	B
Structural System Response Coefficient	ASCE 7, Chapter 12
Total Seismic Dead Loads, W	Actual
Site Soil Classification	D

5.4.6 Soil and Backfill Loads

Lateral backfill loadings on walls and below grade structures will be based upon the recommendations of the geotechnical report. Geotechnical load criteria are indicated in Table 5-6.

Table 5-6 Geotechnical Load Criteria

LATERAL EARTH PRESSURES	
• Active earth pressure (drained)	45 pcf
• Active earth pressure (undrained)	86 pcf
• At-rest (drained)	70 pcf
• At-rest (undrained)	99 pcf

A compaction load will be applied at the top of grade for buried walls to account for extra compaction stresses resulting from using mechanical compaction equipment. The compaction loading will be additive to the lateral earth pressure and will be a constant 400 psf decreasing linearly at the rate of the lateral earth pressure until the lateral earth pressure exceeds 400 psf.

Where vehicular truck traffic can come within a horizontal distance from the top of the structure equal to one-half its exposed height, the design will include a live load surcharge pressure equal to 2-feet of earth for an equivalent H20 truck loading. This surcharge is not to be applied concurrently with the compaction load above.

5.4.7 Equipment and Piping Loads

Piping thrust loads will be considered live loads and will be located and sized prior to structural design.

5.4.8 Impact Loads

Structural systems will be designed for impact loads from machinery and other moving items. Impact loads will be determined in accordance with ACI 350.4R and IBC Section 1607.9 for machinery. Weight of machinery and moving loads will be increased as indicated in Table 5-7.

Table 5-7 Machinery and Moving Load Percentage Increase

PARAMETER	PERCENTAGE INCREASE
Elevator loads, and machinery	100%
Light Machinery, Shaft or Motor Driven	20%
Reciprocating Machinery or Power Driven Units	50%
Hangers for Floors and Balconies	33%

5.4.9 Bridge Crane and Monorail Loads

Bridge crane runway beams and monorail beams will be designed for 125 percent of the rated load for each hoist whether powered or manual hoists are used. Lateral and longitudinal forces shall follow ASCE 7, Sections 4.9.4 and 4.9.5 respectively.

5.4.10 Load Combinations

Building structures, components, and cladding will be designed in accordance with the load combinations contained in IBC, Section 1605 or ASCE 7. Reinforced concrete for non environmental structures will be designed using the load combinations in ACI 318, Section 5.3. Reinforced concrete for environmental structures will be designed using load combinations in ACI 350, Section 9.2.

5.5 DESIGN PROCEDURES

5.5.1 Reinforced Concrete Design

Liquid-containing structures, below grade structures in contact with groundwater in normal conditions, and chemical storage structures will be designed in accordance with ACI 350. Other concrete structures will be designed in accordance with IBC Chapter 19 and ACI 318. Concrete will be designed for 4,000 psi strength even when 4,500 psi strength is specified for construction (higher factor of safety).

5.5.2 Reinforced Masonry Design

Concrete masonry will be designed in accordance with IBC Chapter 21 and ACI 530.

5.5.3 Structural Steel Design

Structural steel will be designed in accordance with IBC Chapter 22, AISC Manual of Steel Construction, and AISC 360.

5.5.4 Aluminum Design

Aluminum will be designed in accordance with IBC Chapter 20, and the Aluminum Design Manual.

5.5.5 Geotechnical Design

Geotechnical design will be in accordance with the criteria indicated in Table 5-8, which is obtained from the recommendations of the geotechnical report. Minimum frost depth for soil bearing foundations will be 36 inches.

Table 5-8 Geotechnical Design Criteria

PARAMETER	CRITERIA
Net-allowable soil bearing pressures	1,500-2,500 psf
Modulus of subgrade reaction, slabs-on-grade	Per Geotechnical Report
Allowable passive earth pressure	320-560 pcf
Soil/concrete coefficient of friction	Per Geotechnical Report
Normal groundwater level elevation	Per Geotechnical Report

5.5.6 Flotation

Structures will be designed to resist flotation based on the weight of the structure including weights of fixed equipment and soil above the top surface of the structure. Safety factors will be as indicated in Table 5-9.

Table 5-9 Floatation Safety Factors

PARAMETER	CRITERIA
Normal Operating Condition	1.25
Extreme Maintenance or Flood Condition	1.1

Water retaining basins will be designed for uplift conditions when drained for maintenance. Uplift may be due to flood, groundwater, or perched groundwater (as determined by the geotechnical report) due to surface runoff or basin leakage. Uplift resistance may be obtained by weight of the structure and/or a pumped underdrain system. The uplift resistance system will be designed in conjunction with the geotechnical engineer.

5.5.7 Impact and Vibration Design

Structures supporting large equipment such as pumps and generators will be investigated for the effects of impact and vibration.

5.5.8 Bridge Crane and Monorail Runway Beam Design

The maximum allowed vertical deflection will be L/800 for bridge crane runway beams and L/450 for monorail runway beams.

5.5.9 Non-Structural Component Design

Non-structural components (architectural, electrical, and mechanical) and their anchorage will be designed by the manufacturer for the seismic requirements specified in ASCE 7, Chapter 13, and shop drawings will be required to be sealed by a registered professional engineer when applicable. Components that are exempted from such requirements, per ASCE 7 criteria, will not require a seismic design or any special submittal requirements. Components located outdoors will also be subject to wind, snow, and ice loading requirements as applicable.

5.5.10 Guardrail, Handrail, Ladder, and Stair Designs

Guardrails, handrails, ladders, and metal stair systems will be performance specified and will be designed by the fabricator. Design will comply with the most stringent requirements of the applicable building code, OHSA 29 CFR Part 1926 Subpart R, and all other pertinent OSHA regulations and local safety regulations. Shop drawings, including calculations, will be required to be sealed by a registered professional engineer.

5.6 SPECIAL INSPECTION REQUIREMENTS

Special inspections during construction are to comply with the applicable building code. The Code Required Special Inspections and Procedures specification will be provided to facilitate the special inspections program.

6.0 Mechanical/HVAC Design Criteria

The following is a description of the HVAC systems that will be included on the project.

6.1 GENERAL

This section presents the criteria and basis of mechanical design associated with the plumbing, heating, ventilating, and air conditioning (HVAC) and fire protection systems. The intent of this section is to define the design criterion, establish the minimum design requirements, and describe the mechanical systems. The selection of the systems will be based on operating performance, system efficiency, life safety considerations, long-term durability, redundancy, local representation/service, ease of operation as well as site and specific requirements identified by the designers and the City of Bonner Springs, KS.

6.2 APPLICABLE STANDARDS

In addition to the applicable codes and standards previously identified, the system designs will also be based on, but not limited to, the following publications and standards:

- American Society of Plumbing Engineers (ASPE) Handbooks
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbooks and Standards
- Sheet Metal and Air Conditioning Contractor National Association (SMACNA) Handbooks
- National Fire Protection Association Recommended Practices (NFPA) and Manuals
- Occupational Safety and Health Act (OSHA) Standards Manual

6.3 LOCATION & METEROLOGICAL DESIGN CRITERIA

Table 6-1 describes the location and meteorological design criteria.

Table 6-1 Location and Meteorological Design Criteria

CRITERIA	VALUE
Site Elevation, above sea level, ft	1005
Site Location[a]	
Kansas City Intl., MO, USA	
North Latitude, degrees	39.297
West Longitude, degrees	94.731
Ambient Design Temperatures [b]	
Winter, design dry bulb, F	7.5
Summer, design dry bulb/mean coincident wet bulb, F	92.7/76.1
Summer, design wet bulb, F	78.3

CRITERIA	VALUE
Climate Zone	4A
Climate Data	
Mean Daily Dry Bulb Temperature Range, F	18.7
Rainfall Intensity [c]	
Actual, inches/hour	3.75
Design, inches/hour	4.0

[a] The site location is for determining representative weather data for the project site but is not necessarily the specific project location.
[b] The winter and summer design temperatures are based on the ASHRAE frequency levels 1.0 percent and 99.0 percent, respectively.
[c] The actual rainfall intensity rate is based on a 60 minute duration and 100 year return period.

6.4 MATERIALS

Materials will be selected giving preference to those materials that require the least maintenance and have the longest life. These are summarized in Table 6-2.

Table 6-2 Mechanical Systems Materials

SYSTEM	MATERIALS
Sanitary Drainage Systems	Cast Iron, PVC
Water Systems	Copper
Natural Gas Systems	Black steel (above grade), Polyethylene (buried)
Plumbing Fixtures	Vitreous China, Cast Iron, Enameled Steel, Stainless Steel, or Composites
Ductwork	Galvanized steel (Special Coating as required)

6.5 SEISMIC

The seismic design will comply with the “Seismic Design Requirements for Nonstructural Components” of the latest edition of American Society of Civil Engineers Standard ASCE/SEI 7, “Minimum Design Loads for Buildings and Other Structures”.

6.6 HEATING AND VENTILATING SYSTEM DESIGN

The following is a description of the HVAC systems that will be included on the project.

6.6.1 Indoor Design Conditions

Table 6-3 describes the indoor design conditions that will be used for the design of the HVAC system.

Table 6-3 Indoor Design Conditions

AREA	DESIGN TEMPERATURES (F) [1]			VENTILATION REQUIREMENTS	VENTILATION NOTES
	SUMMER	WINTER			
	DESIGN	DESIGN	SETPOINT		
Chemical Storage and Process Areas					
Coagulant Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Sodium Hypochlorite Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Fluoride Storage and Feed Room	103	60	55	6 AC/HR (C)	Note 2
Electrical Room	85	60	55	AC	Note 3
Phosphate Storage and Feed	103	60	55	1 cfm/sqft (C)	Note 2
LAS Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Polymer Storage and Feed Room	103	60	55	1 cfm/sqft (C)	Note 2
Gravity Filter Room	103	60	55	1 cfm/sqft (I)	Note 1
Mechanical/Storage	103	60	55	1 cfm/sqft (I)	Note 1
Office Areas					
Offices, Conference Room	75	72	70	AC	Note 3
Parts Storage/Future Personnel	75	72	70	AC	Note 3
Laboratory	75	72	70	AC	
Control Room	75	72	70	AC	Note 3
Server Room	85	60	55	AC	Note 3

[1] Indoor conditions reflect operating temperatures for personnel comfort, code/standard recommendations, or equipment protection.
AC/HR - designates air changes per hour.
(C) - designates the ventilation system operates continuously.
(I) - designates the ventilation system operates intermittently.
AC – designates air conditioning, ventilation provided through AC equipment as required.
Notes:
1. The ventilation system will be sized on the more restrictive of the AC/HR listed or the airflow required to maintain the indoor design temperature based on the summer outside design temperature.
2. Continuous ventilation will be provided at the rate listed. Additional intermittent ventilation will be provided as required to maintain the indoor design temperature based on the summer outside design temperature.
3. The ventilation rate will be based on ventilation or combustion air requirements included in the International Mechanical Code, 2015 edition, or as required for pressurization.

6.6.2 HVAC General Requirements

6.6.2.1 Intakes.

Outdoor air intakes will be designed to manage rain entrainment in accordance with the latest ASHRAE standards. Louvers will be selected to limit water penetration to a maximum of 0.01 oz/ft^2 (3 g/m^2) of louver free area at the maximum intake velocity. Corrosion resistant screens will cover the openings with openings of 1/4 inch (6 mm). Rain hoods will be sized for no more than 500 fpm (2.5 m/s) face velocity with a downward-facing intake such that all air passes vertically upward through a horizontal plane before entering the system.

6.6.2.2 Air Filtration.

Outdoor air will be filtered for areas serving air-conditioned areas. Filtration will consist of 2 inch (50 mm) disposable pleated media filters with a minimum efficiency reporting value (MERV) based on ASHRAE 52.2 guidelines of at least 6.

6.6.2.3 Internal Load Factors.

Heating and cooling loads will be calculated in accordance with ASHRAE Standard 183-2007. Internal heat gains will be included in the calculations based on the following:

- Lighting: 1.3 watts/sq ft (unless otherwise indicated)
- Equipment: Equipment heat loss from equipment anticipated to operate simultaneously

6.6.2.4 Ductwork.

Ductwork will be sized for 0.08 inch water column per 100 feet for a friction loss. Ductwork will be insulated for air conditioning systems, outside air, and heating systems. Insulation will consist of duct liner tested to be resistant to mold growth and erosion under a standardized test method.

6.6.2.5 Outside Air.

Air conditioning and ventilation will be provided in normally occupied areas in accordance with ASHRAE Standards 55 and 62.

6.6.3 Heating Systems

In the Chemical areas, space heating will be provided by either individual electric unit heaters or natural gas unit heaters and will be assessed during design. The heaters will be located to provide uniform space heating of the area served. Each unit heater will be controlled by an adjustable wall mounted thermostat. The electrical and server rooms will be heated with electric unit heaters. The office areas will be heated through natural gas or electric resistance coils within their respective air conditioning equipment. The decision to use electric or natural gas coils will be made during design.

6.6.4 Ventilation Systems

In the Chemical areas, the ventilation systems will consist of continuous and intermittent systems. The continuous ventilation systems serving the Coagulant Storage and Feed Room, Sodium Hypochlorite Storage and Feed Room, Phosphate Storage and Feed, LAS Storage and Feed Room, and Polymer Storage and Feed Room will utilize a common makeup air unit for supply and wall mounted exhaust fans. The makeup air unit will be controlled by a local "ON-OFF" selector switch and each wall mounted exhaust fan will be controlled by a local "ON-OFF-AUTO" selector switch. When each wall mounted exhaust fan selector switch is in the "AUTO" position, the exhaust fan will be interlocked with the makeup air unit. The makeup air unit will filter and temper the air to the room design temperature before being supplied to the space. A thermostat will modulate the discharge air temperature to the design space temperature.

The continuous ventilation system for the Fluoride Storage and Feed Room will receive makeup air from the common makeup air unit and be exhausted through a corrosion resistant fan and ductwork.

6.6.5 Air Conditioning Systems

The air conditioning systems serving the Office area, Electrical Room, and the Server Room will be split systems consisting of air-cooled condensing units and refrigerant coils installed in air handling units. Air cooled condensing units will be used to reject heat from the refrigerant coils to ambient for the air conditioning systems. The condensing units will be located outdoors.

For the office area unit, outdoor air for ventilation will be introduced and conditioned through the air conditioning unit. Where space positive pressurization is desired or required in the electrical and server rooms, outside air will be introduced and conditioned through the air conditioning unit, or by a separate filtration and pressurization unit. Economizers will be provided in areas where ambient air quality is suitable and economizer controls will be based on enthalpy to control humidity and protect electrical equipment.

6.6.6 Building Control Systems

The HVAC controls will consist of automatic industrial grade electromechanical and electronic controls. Control component enclosures will be selected based on the environment where they are installed. Typical controls will consist of the following:

- Differential pressure indication across supply and exhaust fans designed to operate continuously to indicated fan flow or failure. Where insufficient differential pressure occurs due to limited ductwork, motor current switches will be used.
- Duct mounted smoke detectors where systems have airflows greater than 2000 CFM and are capable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.
- Differential pressure gauge and differential pressure switch with alarm across air filters.
- Electric thermostats for control of intermittent ventilation systems to start and stop equipment operation.
- Electric thermostats or electronic sensors to control heating equipment for maintaining the leaving air temperature within the design temperature range.
- Electric thermostats for detection and alarming of low air temperatures.
- Programmable electric thermostats for control of packaged air conditioning systems.

A microprocessor-based standalone system or building automation system (BAS) is not anticipated for the facilities due to the environment and simplicity of the HVAC systems; however, if deemed preferable by the City, a BAS system can be incorporated to replace the electric and electronic controls and provide central monitoring, operation, and management of the HVAC systems.

6.7 PLUMBING DESIGN

6.7.1 Storm Drainage Systems

The primary system serving the Operations Building will consist of gutters and downspouts which will discharge above grade to splash blocks and to a below grade storm drainage system when available and necessary to prevent a nuisance.

6.7.2 Sanitary Drainage Systems

General floor drainage will be provided in the process areas of the Building. Funnel receptors will be located adjacent to equipment with equipment drains. Where practical, receptors will be located to serve multiple equipment drains.

All floor drains, bell-up drains, and plumbing fixtures connected to the sanitary drainage system will be provided with traps and vents. Where individual vents cannot be provided for each trap due to physical constraints, a combination waste and vent system will be utilized for floor drains and funnel receptor drains. All other drains will be individually vented. Piping materials will be cast iron soil pipe with hubless, bell and spigot joints for above grade locations, bell and spigot joints for below grade locations, and PVC schedule 80 for corrosion resistant drainage piping where necessary.

All plumbing fixtures and floor drains located on the floor at or above grade will discharge by gravity to the plant sanitary sewer.

Chemical feed and storage rooms will be provided with containment trenches and will drain to a dry sump within the containment area. A portable sump pump will be used to pump washdown water from the sumps to a bell-up drain. In the event of a chemical spill, the chemical will be pumped to a waste truck for proper disposal.

6.7.3 Water Piping Systems

Potable water from the discharge of the high service pumps will be supplied to the domestic water fixtures and emergency shower/eyewash fixtures. Plant water is drawn downstream of the high service pumps and will be at the distribution system pressure; therefore, no pressure boosting equipment will be required. Where the water pressure exceeds 80 psig, pressure reducing stations will be provided to reduce the water pressure. Water metering equipment will be provided at each building supplied with potable water. Piping materials will consist of soft annealed copper tubing with flared fittings for buried sizes 2 inch and smaller and type K hard drawn copper tubing with solder joint fittings for above grade piping.

All materials in contact with the potable water will comply with the Safe Drinking Water Act of 1986 as amended by the Reduction of Lead in Drinking Water Act of 2011. All plumbing fittings and fixtures intended to convey or dispense water for human consumption will comply with the requirements of NSF/ANSI 61 and NSF/ANSI 372 for low lead.

Protection of the potable water system will be in accordance with local codes or standards. Reduced pressure principle backflow preventers will be provided on the water supply to non-potable water systems. Vacuum breakers will be provided on hose faucets and wall hydrants served by the potable water system when a non-potable water system is not available.

Domestic hot and cold water will be provided to plumbing fixtures as required. An electric water heater and blending valve will be provided in the cold water supply to the emergency shower/eyewash fixtures to permit tepid water temperatures (60°F to 90°F) to be supplied to the fixtures.

Hose faucets will be provided in unfinished areas that may require periodic washdown. Frostproof wall hydrants will be provided at intervals around the exterior of the structures.

6.7.4 Natural Gas Piping Systems

Natural gas for building heat at the Building will be evaluated during design. Piping materials will consist of polyethylene pipe with butt fusion joints for buried sizes 3 inch and larger and socket fusion joints for buried sizes 2 inch and smaller. For above grade and interior locations, pipe will consist of schedule 40 black steel with butt welding fittings for 2-1/2 inch and larger and socket welding or malleable iron fittings for 2 inch and smaller.

6.7.5 Plumbing Fixtures

Plumbing fixtures will be selected for durability and ease of maintenance and housekeeping.

Water heaters in the Operations Building located downstream from a backflow prevention device will be protected by use of an expansion tank.

Emergency shower and eyewash stations will be located in areas where injurious corrosive materials are handled or stored. The emergency fixtures will be located in well lit, highly visible, accessible locations on the same level as the hazard with an obstruction free travel path. The stations will be plumbed to a tepid water supply as described in the water supply piping paragraph, and designed to provide 15 minutes of flow. A floor drain will be located under the emergency shower, unless located in a chemical containment area in which drainage will be routed to the appropriate sump. Each emergency shower and eyewash station will have an alarm device for local and remote alarms. The local alarm will consist of an audible and visible alarm light. Exterior emergency shower and eyewash stations located near loading stations will be freezeproof, through the wall type fixtures.

6.7.6 Building Fire Protection

Fire protection designed to meet the requirements of local codes and applicable NFPA standards will be provided for the Operations Building. Chemical storage rooms of the Operations Building will be protected with an automatic sprinkler system, per local building code, when volume of hazardous chemicals exceed the maximum allowed limit of 500 gallons. The coagulant and sodium hypochlorite chemical rooms will exceed the maximum allowable limits and thus are required to be sprinkler protected. Fire protection will be installed based upon the applicable edition of Codes along with local amendments. Per local building and fire codes, chemical rooms storing coagulant and sodium hypochlorite are classified as group H-4 occupancy.

The following will be used for the building and sprinkler design:

- All hazardous chemical storage areas exceeding maximum allowable quantity limits as allowed by building or fire code will need to be sprinklered.
- Maximum fire flow requirements for the Operations Building is 1,500 gpm for a maximum 2-hour duration-based fire code appendix B adoption.

- Dedicated electrical room and control room will be provided with automatic smoke detection systems and will not be sprinklered.
- Standpipes are not required for the Operations Building due to single story architecture.
- Emergency alarm station and local occupant notification system will be provided for H-4 occupancy rooms.

The following will be used for the fire hydrant and fire water supply design:

- Water supply to fire protection systems will be provided through a new tap to plant potable water distribution pipeline adjacent to the Operations Building. A hydrant flow test will be performed in the vicinity of Operations Building to confirm sufficient flow and pressure is available for fire protection systems. No new pumping units are assumed to be required to boost pressure to meet minimum pressure requirement for building sprinkler systems. The contract documents will include a performance specification for a contractor-designed fire protection system that meets all code requirements.
- The Operations Building will be provided with a hydrant within 400 feet of all portions of the building to be operated by Fire Department during an emergency.
- If needed, new fire hydrants will be provided on the access roads with bollards having sufficient clearance to protect against mechanical damage.
- The farthest hydrant along the fire water main will be sized to provide 1,500 gpm fire flow at minimum 20 psi residual pressure based on the size of the building.
- Water demand for sprinkler system will be approximately 600 gpm at 50 psi residual pressure measured at sprinkler valve station location inside Operations Building.
- The new fire main will be sized to deliver flow and pressure requirements for either fire flow or sprinkler system as listed in this section and designed per NFPA 24.
- Fire pumper trucks will boost the hydrant water pressure to required level using fire truck pump station.
- All control valves on the water supply piping to fire protection system will be electrically monitored by new fire alarm control unit.

7.0 Electrical Design Criteria

This section presents the general electrical design criteria for the electrical power system for the project. The intent is to provide a safe and reliable means of delivering and distributing power while maintaining ease of maintenance as much as possible. The following criterion also addresses several other electrical requirements that are not specifically related to power delivery.

7.1 CODES AND STANDARDS

Electrical design will conform to the latest editions of the following applicable standards and codes:

- National Electrical Code (NEC-NFPA 70), 2011 Edition
- National Electrical Safety Code (NESC)
- Life Safety Code (NFPA-101-AB)
- Standard for Electrical Safety in the Workplace (NFPA 70E)

Standards and codes of the following organizations will also govern where applicable:

- NFPA 820 Fire Protection in Wastewater Treatment & Collection Facilities, 2016 Edition
- American National Standards Institute (ANSI)
- Illuminating Engineers Society (IES)
- Instrument Society of America (ISA)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Insulated Cable Engineers Association (ICEA)
- Occupational Safety and Health Act (OSHA)
- American Society for Testing and Materials (ASTM)
- Underwriters Laboratory (UL)

Applicable federal and local codes and UL listing requirements will be followed. Exit signs, emergency egress lighting, and emergency lighting power supply will conform to requirements of the local code authority.

7.2 ELECTRICAL DISTRIBUTION PLANNING

The following section describes an outline of the power distribution system plan.

7.2.1 New Power Distribution

Power for the new treatment plant will come from the new 12.47kV utility service which will be coordinated and provided by the electric utility (Evergy). A new 12470:480V utility transformer will be provided by the electric utility on-site, the anticipated size of the transformer is 500KVA. The utility metering will be on the secondary of the transformer and the utility service will power a service entrance rated 480V motor control center in the electrical room. The new MCC will feed the adjustable frequency drives (AFDs) for the motors as well as the valve actuators and other equipment throughout the facility. The MCC will also feed a 30kVA 120/240V lighting panel for the new building along with any miscellaneous loads and a 15kVA 120/240V UPS system to feed the PLC and critical control instruments.

An on-site natural gas engine-generator will provide standby power to the MCC. The engine-generator package will consist of an engine-generator, control panel, cooling system, and accessory items all installed outside in a weather proof enclosure on a concrete base. The standby power feed will connect directly to the MCC. The main breaker and the standby main breaker will be controlled by an automatic transfer controller so there is automatic transition between utility and generator power.

7.2.2 Distribution/Utilization Voltages

The following distribution and equipment utilization voltages and ratings will generally be used. Depending on the specific equipment requirements determined in design, there may be some exceptions to the following numbers:

- Engine Generators 480 volts, three-phase
- Building service 480 volts, three-phase
- Motors, 1/2 to 200 hp 480 volts, three-phase
- Motors, less than 1/2 hp 120 volts, single-phase
- Motor Control 120 volts, single-phase
- Lighting 120 volts, single-phase
- Convenience Outlets 120 volts, single-phase

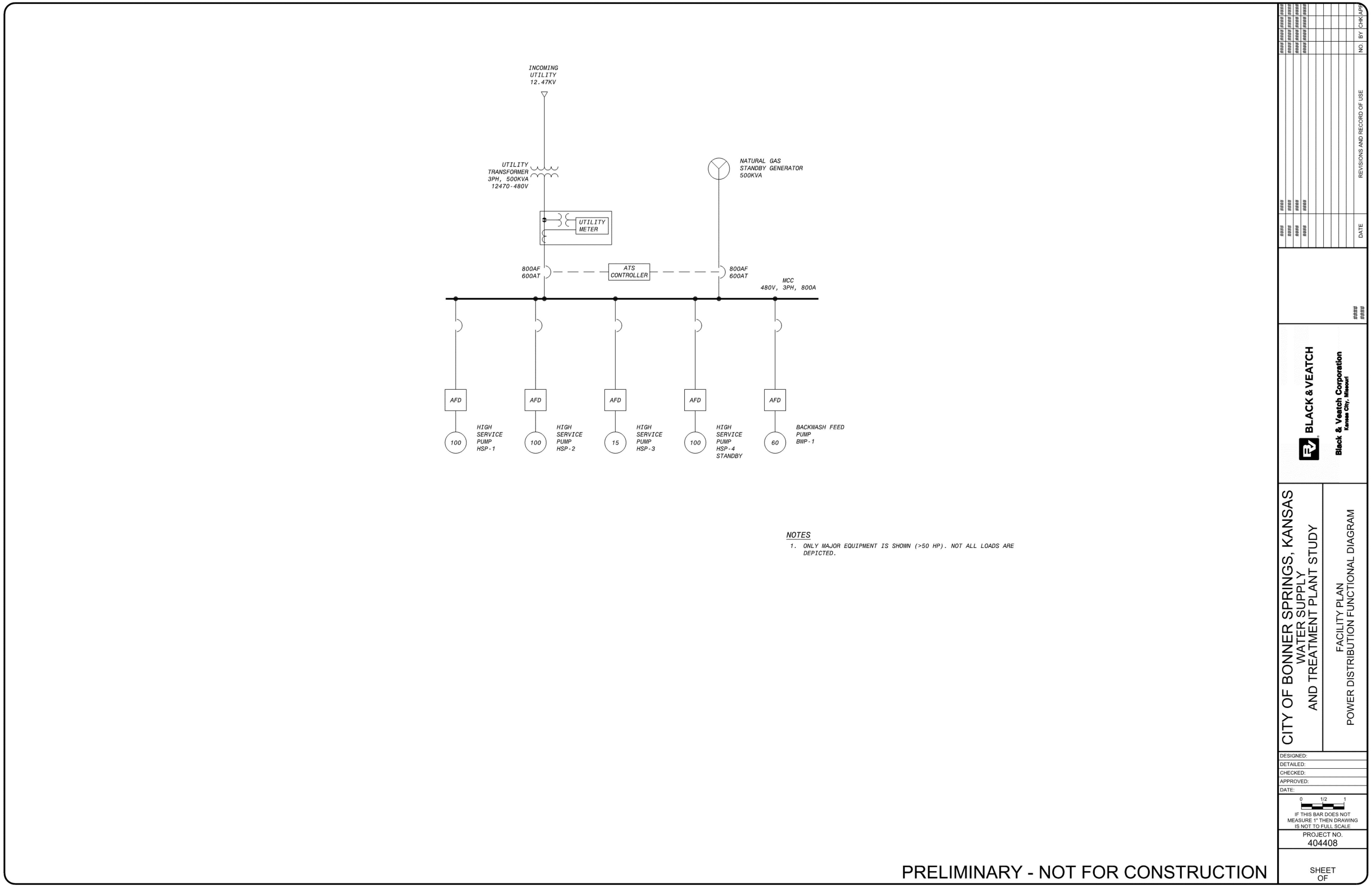


Figure 7-1 **Power Distribution Functional Diagram**

7.3 GENERAL ELECTRICAL CRITERIA

The following criteria identify the general requirements and guidelines to be used for the electrical power equipment and support systems in the electrical design.

7.3.1 480 Volt Switchboard

The incoming power from the outdoor utility transformer will go through a 480V switchboard section housing the utility meter. The switchboard will be service entrance rated.

7.3.2 480 Volt Motor Control Center and Starters

Indoor, class II, type B wiring Motor Control Centers will be used in areas that will contain multiple motors. Supply circuit to Motor Control Centers will be 480 volts, 3-phase, 3-wire. Motor Control Centers will have copper phase buses and a copper ground bus. Motor Control Centers will be 20 inches deep. Some spares and spaces will be allowed (on the order of 10 percent spares and 10 percent spaces) in addition to the identifiable spares required for known future equipment. Transient voltage surge suppressors will be provided integral to each Motor Control Center assembly.

The MCC will be rated to handle short circuit currents equal to or in excess of the available fault current. The MCC main breakers will be a molded case type with solid-state trip unit with long-time (L), short-time (S), instantaneous (I), and ground-fault (G) protection functions. Distribution breakers on the MCCs will be molded case type with solid-state or thermal magnetic trip units. MCCs will measure 20 inches deep. Some spares and spaces will be allotted (on the order of five percent spares and ten percent spaces).

Except for packaged and HVAC equipment, motor starters will generally be located within a Motor Control Center. Starters will include a green indicating lamp for RUNNING, a red indicating lamp for OFF, and an amber indicating lamp for trouble or failure (where applicable). All indicating lights will be LED type.

7.3.3 Motors and Adjustable Frequency Drives

Motors will be specified with high efficiency ratings. Motor enclosures will be suitable for the environment in which they are installed.

All motors will be provided without integral space heaters.

Motors 50 horsepower and above will have adjustable frequency drives. Additionally, motors that need variable pumping outputs will have adjustable frequency drives.

7.3.4 Panelboards

Power distribution panelboards or power centers will be 480Y-volt, three-phase, three-wire type with a main circuit breaker.

Lighting panelboards will be 240/120 volt single-phase with the main circuit breaker sized to match the lighting transformer capacity.

Each panelboard will have a minimum of 20 percent spare breakers with spaces, bus work, and terminations to complete the standard size panelboard. Transient voltage surge suppressors will be provided integral to each panel assembly.

7.3.5 Convenience Receptacles

Convenience receptacles for general service will be located on the surface of walls or columns. Provisions for receptacles at all air conditioning units and air handling units will be made as required by NEC.

Convenience receptacles will generally be mounted 18 inches above floors, except convenience receptacles outdoors or in rooms where equipment may be hosed down will be mounted 48-inches above the floor or grade.

Weatherproof receptacles will be utilized outdoors, in chemical feed and storage areas, and in wet and damp locations. Receptacles installed outdoors will be provided with ground fault circuit interrupting capability.

7.3.6 Raceways

Specific types of raceway will be chosen for use in various locations in the facility based on moisture, temperature, and exposure to damage, corrosion, voltage, and cost. An underground duct bank consisting of concrete encased PVC conduits will be provided for most circuits that are routed outside of buildings on the site. Duct banks will include spare conduits. The following systems will be separately grouped in duct banks:

- Power and discrete control wiring below 600 volts.
- Adjustable frequency drive power circuits will be in steel conduit.
- Process instrumentation analog and communication wiring, including 24 volt discrete signals, intrinsically safe circuits, and LAN/Data Highway computer circuits.

The following general guidelines will be used for raceway sizing, selection, and installation:

- Conduit will be sized based on XHHW-2 insulation for all conductors 600 volts and below.
- The minimum diameter of exposed conduit in all areas will be 3/4 inch.
- Raceways in duct banks will generally not be smaller than 2 inches.
- Raceways in walls and ceilings of control rooms, offices, and all areas with finished interiors will be concealed.
- The number of conduit bends will be limited to an equivalent of 270 degrees on long runs.
- Exterior, exposed conduit will be PVC coated rigid galvanized steel. The use of this type of conduit will be limited to required areas only.
- Exterior, underground, direct buried and concrete-encased conduit will be PVC Schedule 40.
- Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations will be reinforced.
- Interior, exposed conduit will be Rigid Galvanized Steel (RGS).
- PVC Schedule 80 conduit will be used for corrosive chemical areas.
- Interior, concealed conduit will be PVC Schedule 40.

7.3.7 Cable

All lighting, power, and control wiring rated 600 volts and below will use stranded copper conductors with THHN - THWN insulation. Individual No. 14 AWG conductors will be used for discrete control circuits, unless it is practical to use multi-conductor cables to group control circuits. Cables will have 600V insulation.

Twisted-shielded pair control cable with 16 AWG individual stranded copper conductors, PVC insulation, and an aluminum mylar tape shield around the pair will be used for analog signals. Multi-pair cables will be used where grouping of circuits is practical. Cables will have 600V insulation.

7.3.8 Grounding and Lightning Protection

The electrical system and equipment will be grounded in compliance with the NFPA National Electrical Code (NEC). Conductors will be No. 4/0 AWG copper, minimum, for interconnecting ground rods and for connections to transformers and MCCs. A grounding ring will be provided around all new buildings and major structures. Electrical equipment, devices, panelboards, and metallic raceways that do not carry current will be connected to the ground conductors. Transformer neutrals of wye-connected transformers will be solidly grounded through a grounding conductor connected to the grounding system.

A ground wire will be installed in all raceways that contain power conductors at any voltage.

A lightning risk factor calculation will be completed for the project. If the calculated risk of lightning strike is substantial, lightning protection systems meeting the requirements of NFPA 780, Standard for Lightning Protection Systems, will be provided for the appropriate buildings or structures.

7.3.9 Lighting Requirements

Exterior lighting will be provided for all new structures at the WTP. Exterior and indoor light fixtures will be LED type fixtures.

Lighting levels in the facilities will be provided following the recommended levels as suggested in the Illumination Engineering Society (IES) handbook. LED types of light fixtures will be used for all areas.

In general, the following suggested foot candle levels will be the target levels for design. Actual levels provided will be further evaluated in detailed design. Suggested levels are:

Table 7-1 Targeted Design Foot-Candle Levels

AREA	FOOT CANDLE
Electrical Rooms	35
Control Rooms	30
Conference Rooms	40
General Site	1
Lunchrooms	35
Laboratories	75
Maintenance Areas	50
Office	70
Process, outside	5
Process, inside	30
Storage	15
Walkway	5

7.3.10 Fire Alarm Systems

Fire alarm systems will be installed as required in new buildings. Where required, smoke detectors, sprinkler flow switches, ventilation flow switches, combustible gas detectors, heat detectors, audible and visual alarms, and manual fire stations will be connected to a central fire alarm control panel, as required. Partial design of the fire protection system will adhere to local building code requirements. Final design of fire alarm system will be via performance specification in the contract. Contractor will be required to procure the service of a local fire alarm system supplier who will be responsible for determining all local fire code requirements and submitting a complete design which complies with those requirements.

7.3.11 Security System

Security system equipment will be included in new buildings on the plant site. At a minimum, magnetic door contacts, which signal an exterior door has been opened, will be connected to the plant control system PLC. Provisions for connections to remote locations will be provided as required and as determined in final design.

Input on additional security requirements will be required by the City prior to the completion of the final design phase. Examples of advanced security features may include electronic building and site access or motion detectors. The specific type and level of security protection will need to be coordinated with the City based on their needs at the Bonner Springs Water Treatment Plant.

7.3.12 Load Study/Short Circuit/Voltage Drop Analysis/Coordination Study

A load analysis will be prepared during final design to help plan the power distribution system. Major loads, including the estimated value of connected loads and peak running loads will be calculated. Redundant and standby units will be excluded from the total connected load to establish the critical running load requirements.

A preliminary short circuit analysis will be prepared during the final design phase to properly specify the equipment in the power distribution system. A short circuit current calculation along with a protective device analysis will be required to be submitted by the contractor during the construction phase. The contractor will be required to submit final short circuit and coordination study documents and data in paper form and in PDF electronic file form on CD-ROM for delivery to the Engineer and Owner during construction and prior to electrical start-up.

7.3.13 Arc Flash Hazard Analysis/Short Circuit Study/Coordination

During the construction phase of the project, an arc flash hazard analysis will be specified to be commissioned by the contractor. The analysis will cover all pieces of electrical equipment in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584. The arc flash analysis will be performed in coordination with the short circuit and coordination studies. Arc flash study results will be used to properly label all electrical equipment as to the severity of the arc flash hazard and the minimum personal (PPE) required to perform work on each piece of energized equipment.

8.0 Instrumentation and Controls (I&C) Design Criteria

The Instrumentation and Controls (I&C) System for the City of Bonner Springs, KS Water Treatment Plant, referred to as the Plant Control System (PCS), will focus on efficient and reliable monitoring and control of equipment and processes. All I&C work will be in accordance with local and state codes, the criteria outlined in this section, other requirements applicable to the I&C design of a water treatment facility and City's system objectives. A control block diagram illustrating proposed PCS components is provided as part of this Report as Figure 8-1.

8.1 CODES AND STANDARDS

All I&C work will adhere to the latest editions of the following applicable standards and codes:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronics Engineers (IEEE)
- International Society of Automation (ISA)
- National Electric Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)
- Occupational Safety and Health Administration (OSHA)
- Underwriters Laboratories (UL)

Applicable federal and local codes and UL listing requirements will be followed. All electrical equipment, conduit, and wiring will be UL listed.

8.2 INSTRUMENTATION AND CONTROL REQUIREMENTS

The I&C system design will adhere to Black & Veatch engineering standards and industry best practices except when accommodating any of the City's standards or preferences. Instrumentation and control devices will be based on standard Black & Veatch specifications, except where specific models or types of devices are requested by the City.

8.3 INSTRUMENTATION AND I/O SIGNAL STANDARDS

Analog field instrumentation will utilize 4-20 mA DC signals to/from the programmable logic controller (PLC). Four-wire instruments will be powered by 120 volts AC. Discrete PLC input and output (I/O) signals will utilize 120 volt AC signals to and from the PLC.

Where a software network is available, network devices will communicate over an Ethernet-based protocol.

8.4 PLANT CONTROL SYSTEM

The proposed PCS will consist of a PLC based control system with a Supervisory Control And Data Acquisition (SCADA) system front end to provide efficient and reliable monitoring and control of plant equipment and processes. The PLC-based control system will be designed in a distributed configuration, with PLCs installed at various locations across the new treatment plant. Each PLC enclosure will monitor and control field instrumentation, equipment, and vendor packaged systems via hardwired I/O signals or via a digital communication network. All instrumentation and equipment interfacing with the various PLCs will be made available to the SCADA system, allowing facility processes to be monitored and controlled by operators from Human-Machine Interface (HMI) workstations.

Control system equipment will be selected and standardized to maintain system reliability, improve ease of use, and to facilitate maintenance activities. The PLCs will provide a means of controlling plant equipment and processes and will provide adequate alarming and monitoring to ensure a safe shutdown of systems should a failure or alarm condition occur. The control system will be programmed to provide an appropriate level of automation for the controlled process and will operate without dependence on continuous operator input. Manual hardwired controls, with local/remote switching capability, will be provided at the field device level near controlled equipment to allow continued operation of critical system processes regardless of control system operational status. Field instrumentation and panel mounted devices allow for system performance to be monitored and field verified independently of the control system.

The WTP will be monitored and controlled through a SCADA software platform. The SCADA software will be fully featured and will handle all HMI, historical data logging, trending, alarming, and reporting functionality. Various industry standard SCADA software solutions providing this functionality include Wonderware InTouch and System Platform, Rockwell FactoryTalk, GE iFIX, Trihedral VTScada and Inductive Automation Ignition. The SCADA software will be further evaluated during detailed design to select a solution that will meet the City's required features and any expandability and accessibility requirements. If the City intends to receive continued PCS support from a third-party system integrator, the integrator's familiarity with the SCADA software be considered in order to facilitate any support services.

The SCADA and PLC software will be fully installed, configured, and tested by a subcontracted system integrator. The PCS will incorporate new plant equipment and processes and provide any remote control functionality. Process graphics, alarms, status information, trending, reporting, and historical database points will be configured for the new SCADA system as a part of this project. All processing will occur at the PLC level. The HMI will issue any setpoints, parameters, and commands to the PLC where the PLC will then execute any control algorithms and control equipment. Any processing at the workstation or server computer will not disrupt plant control.

8.4.1 Programmable Logic Controllers

The PCS will consist of multiple PLCs distributed across the new WTP. Conceptual design assumes the following:

Table 8-1 Preliminary PLC Locations

PLC DESCRIPTION	LOCATION	SERVICE
Process PLC	Server/Safe Room (Operations Building)	Plant Influent, Filtration, Softening Equipment, Recarbonation, Backwash Recovery Pumps, Backup Power Generator
Chemical Feed PLC	Server/Safe Room (Operations Building)	Chemical Metering
HSPS (High Service Pump Station) PLC	High Service Pump Station	HSPS Pumps, Backwash Supply Pumps, Flow Control

PLCs will interface with equipment – including adjustable frequency drives, motor control centers, and local control panels – and instrumentation at the treatment facility. The PLCs will gather process and performance information from the equipment and instrumentation and execute control strategies. A subcontractor, regularly engaged in system integration, will provide, install, and program the various PLCs. The PLCs will be an industrial-type, rack-based, modular, microprocessor-based system allowing for I/O and communication requirements to be selected and scaled according to process requirements. Industry standard PLCs, such as those manufactured by Allen-Bradley, GE, Schneider Electric/Modicon, or Siemens will be provided. Specific models will be refined as control requirements are determined during detailed design phases.

The Contractor will provide and install enclosures at specified locations to house PLC equipment and to terminate any field I/O or PLC communication cabling. PLC enclosures will be installed in locations with a high density of monitored and controlled equipment and instrumentation in order to minimize wiring requirements and to consolidate control hardware. The PLCs will communicate with the SCADA system and any other networked equipment via an Ethernet-based communication network. PLC communication media will be a combination of fiber optic and CAT 6 cable. The enclosures will be installed complete with a managed Ethernet switch and with any additional panel appurtenances, including but not limited to, interposing relays, terminal strips, power distribution equipment, and surge suppression hardware. The enclosures will also be furnished with an uninterruptible power supply (UPS) and redundant control power supplies. Power supply failures and UPS alarms will be alarmed at the HMI.

PLC design will account for known future equipment and will be sized for future expansion. Special consideration will be given to the distribution of I/O points across a PLC's modules to minimize the amount of equipment affected by a module failure. Communication modules at each enclosure will be compatible with an Ethernet-based network. All I/O and communication modules and any other pertinent PLC accessories will be of the same manufacturer to minimize compatibility issues.

Where practicable, PLC enclosures will also serve as the local control panel for any non-packaged equipment. Where additional controls are required beyond local actuator or packaged equipment controls, any indicating lights, switches, pushbuttons, operator interface terminals (OITs), or alarm devices will be centrally located on the nearest PLC enclosure. If the final location of an enclosure is not conducive to an operator's ability to supervise the controlled equipment, an additional local control panel may be provided.

8.4.2 Plant Network

The rack-style network enclosure will be provided and installed in the Server/Safe room to house the following network equipment:

- Redundant PLC/SCADA Network Switch
- Administrative/Corporate Network Switch
- Security Network Switch
- Redundant PCS I/O Servers
- Historian Server
- Authentication Server
- Fiber optic and metallic twisted pair Ethernet cable patch panels
- Network Firewall
- Uninterruptible Power Supply

The plant network architecture will consist of an Ethernet-based Local Area Network (LAN). Within building envelopes, CAT 6 cable will be used for digital network communication. Shielded twisted pair Ethernet cable will be used when routing cable through process areas. Fiber optic cabling will be used outside of building envelopes or where networked device locations exceed the recommended maximum Ethernet twisted-pair cabling distance. PLC and SCADA traffic will utilize the same physical network cabling and hardware and all traffic will be routed through the PLC/SCADA network switch. Any administrative traffic and Internet Protocol (IP) security camera network traffic will be routed through their respective switches on separate cabling.

If network hardware is shared by multiple networks, the networks will be segmented at the Data Link layer by configuring separate Virtual Local Area Networks (VLAN) for each type of traffic. In addition to VLAN segregation, network IP addressing will be logically separated by implementing structured subnet groups. All network cabling and hardware will support a minimum of 100BaseTX/100BaseFX duplex Ethernet networks. All network equipment will be provided, installed and configured by the Contractor as a part of this project. All network hardware will be powered by an uninterruptible power supply and redundant power supplies. Additionally, network communication status will be monitored at all times. Disruption of any network communication will be alarmed at the HMI.

In order to support administrative functions such as email, web-browsing, and Voice-over-IP (VoIP), a broadband Internet service plan may be required. The existing administrative / maintenance building at the current water treatment plant may already have an existing Internet connection. This interconnection will be further evaluated during detailed design phases. If possible, the existing Internet connection will be reutilized.

8.4.3 Computer Control System

The WTP Operations Building will feature a control room. Two operator HMI workstations and an engineering workstation will be installed in the control room, allowing City personnel to monitor and control facility equipment and processes from an on-site location. Each HMI workstation will be configured with the same SCADA application to maintain operational consistency. The two workstations will provide redundancy in the event of a workstation failure. The engineering workstation will be loaded with a full development version of the SCADA software and used to configure graphics, test and deploy operating system and anti-malware updates and patches, To improve system security, the HMI will require a user-specific password log-in and be configured with administrative control levels based on user privileges. Inactive sessions will timeout after a predefined time period to prevent unintended access from an unsupervised workstation.

The WTP SCADA software will operate on redundant PCS I/O servers installed in a network rack in the Server/Safe room. The server will be a rack-mounted server-class computer running on a Microsoft operating system. The servers will be equipped with multi-core processors and sufficient memory and storage to support PCS requirements. The PCS I/O servers will communicate with PLCs over the plant network and update the HMIs with process and equipment information and alarms. The redundant PCS I/O servers will handle all I/O server functionality, terminal services. Historian services and any user authentication features will be handled by separate dedicated servers.

Additional control room equipment requirements such as furniture, monitors, printers, or IP phones will be elicited from the City during detailed design phases.

In addition to workstations located in the control room, a workstation will be provided in the Operation Building Laboratory. The workstation will interface with the SCADA system or any external servers as required by the City.

The City has expressed an interest in the ability to access the PCS remotely. It is anticipated that the site may not be staffed at all times. Accordingly, remote access to the PCS HMI, trending, historian, reporting, and alarming features must be available to provide the City with the ability to continuously monitor and control the facility. Various SCADA software platforms feature remote access solutions. As an alternative, an encrypted virtual private network (VPN) connection may allow plant personnel to access any required PCS functions through a dedicated PCS laptop. PCS security will be evaluated based on the City's remote access requirements.

8.4.4 Security

To improve site security, security cameras, intrusion alarms, and access control will be implemented across the facility. Exterior doors will require card access and will be equipped with intrusion/proximity switches.

Security cameras will be installed at locations across the water treatment plant and will be accessible from the control room. Where practical, IP security cameras will be provided and powered over their network interface (PoE, Power over Ethernet) according to IEEE 802.3af/at standards to minimize power cabling requirements.

8.4.5 Existing/Vendor Systems

The PCS will be designed to interface with both existing and vendor systems. The current water treatment plant utilizes radio telemetry to communicate with remote wells, storage tanks, and booster pump stations. Radio telemetry equipment condition will be verified during detailed design phases to determine its suitability for use at the new water treatment plant. If the telemetry equipment is in an acceptable condition and meets PCS interconnection requirements, it will be reutilized to incorporate telemetry information from remote facilities. If these criteria are not met, telemetry equipment will be replaced with an equivalent device to the extent possible in order to minimize telemetry configuration requirements.

In the case of vendor systems, status and alarm information will be monitored by the PLC and relayed to the HMI. Any required signals will be incorporated into the PCS for controlling vendor equipment. Equipment may include packaged process equipment, fire protection equipment, and backup power generators. Where possible, communication with networked packaged equipment will use an Ethernet-based network to minimize protocol compatibility issues.

Fire alarm and detection system will be provided as indicated in the Fire Alarm Systems section. The Fire Alarm System components will be interconnected as required for alarming at the HMI.

8.4.6 System Configuration

Configuration of the PCS will be the responsibility of the Contractor through the use of a local system integrator. This will include the configuration of the servers, workstations, PLCs, operator interface terminals (OITs), and HMIs. The configuration also includes graphic display development, system database and reports. Standards will be developed with the City and documented during detailed design and construction phases.

8.4.7 Instrumentation

Plant instrumentation is provided to support monitoring and control of the process and equipment systems. Additional instrumentation is provided to alarm abnormal system operation or safety hazard conditions. Where possible, instruments will be microprocessor based 'smart' instruments, which can be calibrated and maintained through a digital interface. Instrumentation will be based on standard Black & Veatch specifications, except where specific models are requested by the City.

All instruments, switches, and control sensors are to be rated for the environment in which they will be located. In general, devices mounted indoors (air conditioned & non-air conditioned) shall be NEMA 12 rated. Devices mounted outdoors or in wet or corrosive environments (indoors or outdoors) will be NEMA 4X rated.

All wetted materials need to be chemically compatible with the process fluid. For highly corrosive process applications, diaphragm seals or annular seals shall be provided as indicated on the Contract Drawings. All diaphragm and annular seals are to be factory sealed with fill fluid as designated by the contract documents. No field assembly of diaphragm seals or annular seals shall be done except by a factory trained technician.

All instruments are to be industrial grade with UL, FM, or equivalent listing for the installation environment.

Flow Instrumentation
It is currently anticipated that magnetic type flow meters will be used for liquid flow measurement in full pipe applications. Magnetic type flow meters are a proven technology widely used in water and wastewater facilities. Thermal mass flow meters will be used for air and gas flow measurements. Flow switches will be provided for emergency showers and eyewash stations.

Level Instrumentation
Level measurement technology for enclosed tanks is expected to be flange-mounted pressure sensing level transmitters. Enclosed tanks containing harsh chemicals will utilize non-contacting ultrasonic type level instruments. Level measurement technology for basins or holding tanks where foaming is anticipated will be radar type or submersible pressure probe level instruments, while basins with no foaming will utilize ultrasonic type level instruments. Scales will be used to measure chemical tote levels.

Pressure Instrumentation

Pressure instrumentation consisting of digital pressure transmitters, dial-type gauges, and switches will be provided for monitoring equipment and process variables and to provide equipment protection. Digital pressure transmitters will utilize diaphragms to isolate the pressure element from process fluid. Pressure elements will be mounted to 3-way valve manifolds for calibration, testing, and mounting of dial-type pressure gauges.

Analytical Instrumentation

Analyzers will be used to measure water quality of process fluids and air quality of process spaces. Analyzers are available in a variety of form factors such as offline sample systems, pipe insertion probes, or channel insertion probes. Preferred form factors will be pipe insertion probes or channel insertion probes, but the form factor will ultimately be selected based on accuracy required for the process. All analyzer instruments will be manufactured by the same company where possible. Chlorine residual and pH analyzers are anticipated to be implemented measure process quality.

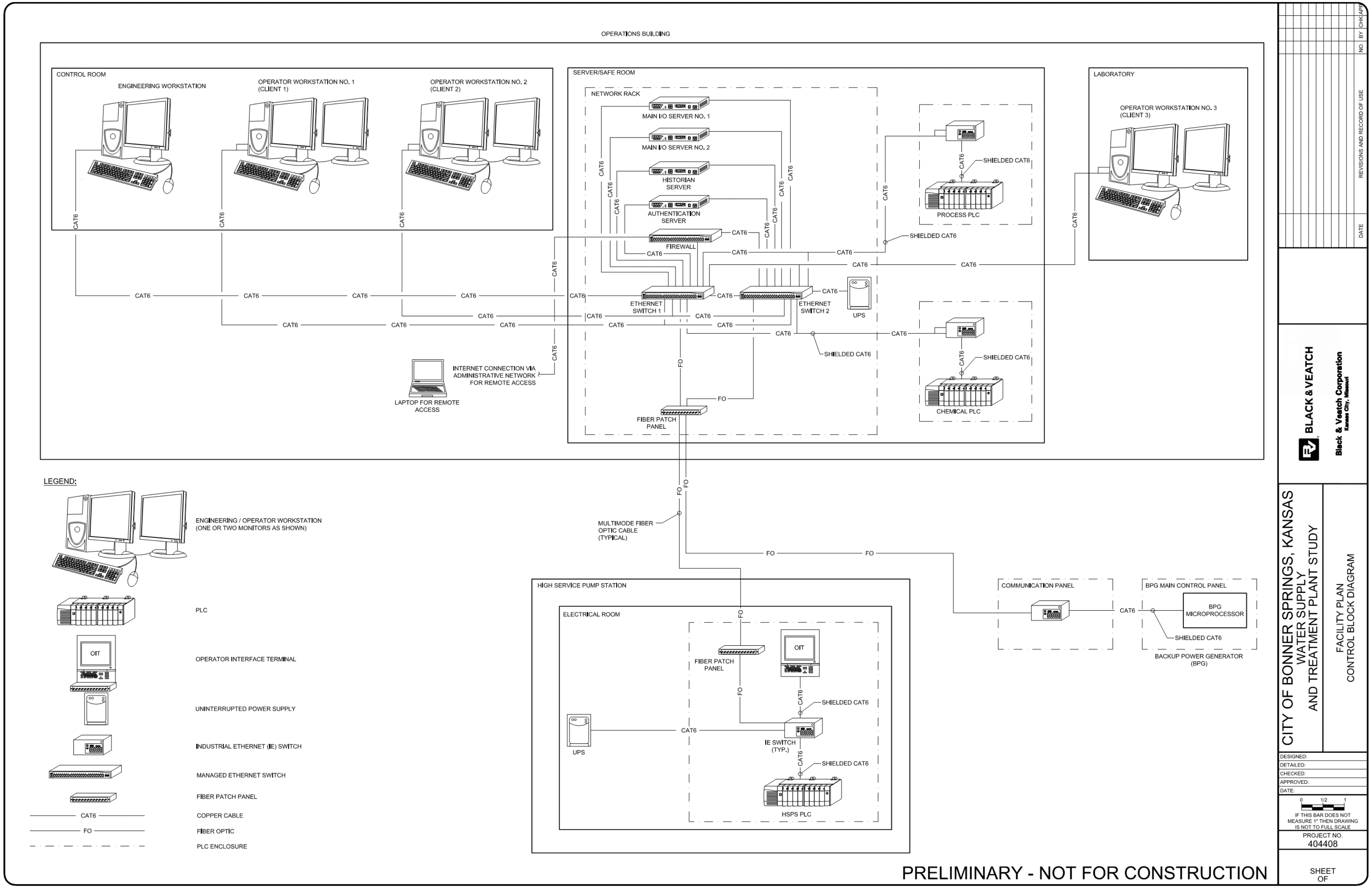


Figure 8-1 Control Block Diagram

8.5 CONTROL SYSTEM DESIGN STANDARDS

8.5.1 P&ID Drawings

P&IDs to be developed during detailed design phases will include all major processes associated with the new facility. Drawing format will follow Black & Veatch standard drawing procedures. Drawings will be schematic in nature. The tagging convention used on P&ID drawings will be based on the ANSI/ISA-5.1-2009 standard as indicated in the following section.

8.5.2 Equipment Tagging Convention

An equipment tagging convention will be used to designate all major equipment and process instrumentation included in this project. Equipment tags will consist of letter designations to describe the System Code and Function Code followed by a three digit Sequence Code. In general, the tagging convention will follow ANSI/ISA-5.1-2009 Instrumentation Symbols and Identification standards.

Equipment tag structure is summarized in the figure below:

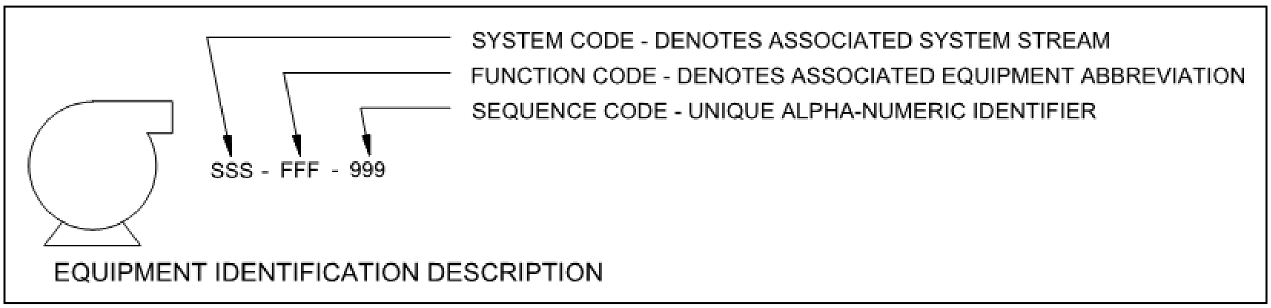


Figure 8-2 Equipment Tagging Convention

System Code – System Codes are abbreviations of the processes and systems involved in the project. Processes include treatment systems, chemical feed systems, pumping systems, and storage systems.

Function Code – Function Codes describe the type of equipment or its function. This code consists of a series of 1 to 4 letters that abbreviate the specific equipment function or type. Designations generally follow ANSI/ISA-5.1-2009.

Sequence Code – Sequence Codes are three digit numbers providing a unique identifier such that equipment that may have the same System Code and Function Code can be distinguished.

8.6 CONTROL MODES

In general, the equipment at the water treatment plant will be operated in one or more of the following control modes:

- **Local Manual**: The equipment is manually controlled from an Adjustable Frequency Drive (AFD), Motor Control Center (MCC), local control panel, or from local equipment operator (e.g., valve actuator).
- **Local Automatic**: The equipment is automatically controlled locally by the packaged equipment PLC or through a hardwired interlocking scheme.

- **Remote Manual**: The equipment is manually controlled through the PLC based on commands issued from an HMI. Such commands are received by the PLC and converted into physical outputs to field devices.
- **Remote Automatic**: The equipment will be automatically controlled through the PLC according to measured process parameters or calculated values received from field devices or remote PLCs and upon commands and setpoints issued from an HMI. Such commands, setpoints, and process values are received by the local PLC, processed, and converted into physical outputs to field devices in order to maintain a process setpoint or specific control scheme. Some equipment may have more than one remote automatic control mode.

In all control modes, hardwired equipment interlocks will be used to shut down equipment as required to protect plant personnel or equipment. Where such interlocks and permissive signals are monitored by the control system, the PLC will discontinue the control output to equipment, concurrent with the equipment's interruption by the hardwired circuit.

The control mode will be selectable where applicable according to local/remote and auto/manual switches located at the devices, AFD, MCC, and/or control panels. Selector switch position feedback will be wired to the PLC, allowing an operator to know whether a device is available for remote control from the HMI.

Some non-process equipment will be provided with local manual and local automatic controls only. Where applicable, packaged equipment items that are normally provided with local automatic controls will be specified accordingly. The PLC will be used to monitor such equipment and, when applicable, provide remote initiation, monitoring, and alarming.

8.7 EQUIPMENT CONTROLS

The specific equipment controls for each process will be developed into process control software block descriptions and will be provided as part of the bid documents.

Specific interlocks, permissives, alarms, and automatic control strategies will be further developed during detailed design phases. A process may have multiple automatic control modes. The following table describes the various modes of control available for specific processes.

Table 8-1 Automation Philosophy

PROCESS DESCRIPTION
Gravity Filters
A. **Local Manual Control:** Valve actuators associated with the gravity filters may be manually operated. B. **Local Automatic Control:** None. C. **Remote Manual Control:** Manual control of valve actuators associated with the gravity filters will be available at PCS HMI. D. **Remote Automatic Control:** The PCS will modulate influent flow, filtrate flow, and will initiate backwash cycles based on operator-entered setpoints.

PROCESS DESCRIPTION

Backwash Supply Pump

A. **Local Manual Control:** Pump controls will be available at the local control station.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the backwash supply pump will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The PCS will start, stop and modulate pump speed to maintain an operator-entered flow setpoint.

* In the event of a Backwash Supply Pump failure, one High Service Water Pump connected to the Backwash Supply Header will serve as a backup pump. To be coordinated during detailed design.

Backwash Filter Return Pumps

A. **Local Manual Control:** Pump controls will be available at the AFD panel.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of backwash filter return pumps will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered flow setpoint.

High Service Water Pumps

A. **Local Manual Control:** Pump controls will be available at the AFD panel.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of high service pump will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag1/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered setpoint. Several remote automatic control modes may be available, allowing operators to toggle between flow control, pressure control, and level control.

*Note a separately sized pump will be provided for the Lake of the Forest service area. Ability to use the backup pump as a backup for this service area will be evaluated during design.

High-Rate Clarifier Equipment System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** The softening equipment system will be supplied as a vendor package. It is anticipated that most control will be at the vendor package level with supervisory commands issued by the PCS. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the system will be available at the PCS HMI.

D. **Remote Automatic Control:** The PCS will issue start/stop commands to the vendor softening equipment system. Remote automatic controls to be further refined during detailed design phases.

PROCESS DESCRIPTION

Chemical Feed Systems

Sodium Hypochlorite Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Coagulant Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Fluoride Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Phosphate Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Duty/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

PROCESS DESCRIPTION

Liquid Ammonium Sulfate Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Polymer Feed System

A. **Local Manual Control:** Manual controls will be available on the metering pump local control panels.

B. **Local Automatic Control:** None.

C. **Remote Manual Control:** Manual control of the feed pumps will be available at the PCS HMI. Control of pump operation and speed will be available at the PCS HMI.

D. **Remote Automatic Control:** The pumps will operate in a Lead/Lag/Standby configuration and the PCS will modulate pump speed to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Carbon Dioxide Feed System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** It is anticipated that the carbon dioxide feed system will be supplied as a vendor package. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the feeder system will be available at the PCS HMI. Control of feeder operation and feed rate will be available at the PCS HMI.
D. **Remote Automatic Control:** None.

Lime Feed System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** It is anticipated that the lime feed system will be supplied as a vendor package. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the feed system will be available at the PCS HMI. Control of system operation and feed rate will be available at the PCS HMI.

D. **Remote Automatic Control:** The feeders will operate in a Duty/Standby configuration and the PCS will modulate feed rate to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

PROCESS DESCRIPTION

Soda Ash Feed System

A. **Local Manual Control:** Manual controls will be available on the system control panel.

B. **Local Automatic Control:** It is anticipated that the soda ash feed system will be supplied as a vendor package. Local automatic controls to be further refined during detailed design phases.

C. **Remote Manual Control:** Manual control of the feed system will be available at the PCS HMI. Control of system operation and feed rate will be available at the PCS HMI.

D. **Remote Automatic Control:** The feed pumps will operate in a Duty/Standby configuration and the PCS will modulate feed rate to maintain an operator-entered dosage setpoint. Additional detail on the feedback parameters and calculations will be determined during detailed design.

Backup Power Generator

A. **Local Manual Control:** Manual controls will be available on the engine-generator control panel.

B. **Local Automatic Control:** The engine-generator packaged will be equipped with a microcontroller to provide automatic control at the local level.

C. **Remote Manual Control:** Manual control of the generator will be available at the PCS HMI.

D. **Remote Automatic Control:** None.